ENGINEERING NEWS.

Tribune Building, New York City.
GEO. H. FROST, PROPRIETOR.

SATURDAY, MARCH 26, 1881.

WE publish the River and Harbor Appropriation bill in full this week, a service our contracting friends will no doubt appreciate.

A CONVENTION of superintendents and other officers of water-works will be held at the Washington University, in St. Louis, Mo., on Tuesday, March 29, 1881, the use of the halls having been kindly tendered gratuitously by the faculty of that institution.

It is respectfully and earnestly requested by the committee that every superintendent will attend and assist in rendering the convention a success and mutually beneficial.

LANDMARKS.

Among the many interesting topics discussed at the recent meeting of the Michigan Association of Surveyors and Civil Engineers was that of the best means of perpetuating the monuments at the township and section corners. The State was surveyed some fifty odd years ago, it appears, on the rectangular public land system, and probably mostly by contractors. The monuments consisted of mounds of earth and wooden stakes or posts, guarded by blazed witness trees when possible. These are now generally very difficult to find or recognize, owing to the disappearance of the witness trees, the decay of the wooden posts and the leveling of the mounds by animals. As surveyors now retrace the township and section lines, they meet with numerous troubles and vexations, caused by the lax system of the early contractors, and in re-establishing the landmarks they take pride so to do it that future generations may be spared similar tribulations. Moreover, there has been manifested a feeling that some system of monumenting should be carefully established, so that there may be uniformity and law governing the shapes and sizes, the depths at which they shall be set, the letters and signs to be placed upon them and the auxiliary guards to be stationed near them.

One plan discussed at the recent convention was for vitrified stone stakes manufactured from ground stone and clay, and pressed and baked. These possess the great recommendation of being indestructible by fire or atmospheric agencies, and the disadvantage of being broken by violence like earthenware. The sizes thought most favorable were simple cylinders three inches in diameter, and varying from one to three feet in length. Had stakes of this kind been used in the original surveys much annoyance and litigation would have been avoided. Such a stake seems to possess some advantages in cheapness, portability and indestructibility over the stone monuments used in cities for street corners and boundary lines. In some cities it is the practice to drill a hole in the center of the stone; this renders it more liable to the action of frost, and is a temptation to boys to place powder therein and ignite it. For durability we have been able to think of nothing better than a tough, vitrified stake.

The most troublesome point of all, however, is how to place the stake so that it shall be seen by those interested and still not be liable to destruction. On this point opinions are varied. One way would be to bury it just below the surface and take its bearings from numerous houses and trees; but this would be open to the same objection as the old system of witness trees. Another way is to raise a mound over it; but this, unless the mound be large, is objectionable as liable to destruction by rain and by animals. Still another way is to plant around the stake some peculiar bush or tree or some weed like tansy which is very persistent and yet does not spread; but these would be liable to destruction by fire and by the farmers who did not appreciate their use and value. And still another plan is to bury some three feet deep under the stake a mass of magnetic iron so that the surveyor walking to and fro over the ground with a sensitive dipping needle in his hand may be guided to the exact spot; but this is objectionable on account of the expense. Theoretically we may take the immovable stars as reference points and determine the precise latitude and longitude of the corner; but practically it is impossible on account of the great cost and lack of required precision in the result.

Whichever way we turn, and whatever plan we adopt, there may be found, aside from the question of expense even, some objection based either on want of durability or difficulty of recognition. No monument can last forever, or even for a thousand years, and be sure of definite recovery from the original record of establishment. Whether we use the cast-iron stake, or the stone pillar with a hole bored therein, or the vitrified stone cylinder, destruction and disintegration will some time be sure to occur. All we can do is to arrange things that the time of obliteration will be as far hence as possible. The discussions of the conventions of surveyors in Ohio, Michigan and Pennsylvania have done much to further this very desirable aim, and we trust they will be continued at future meetings until a careful and thorough system shall have been elaborated for the establishment, preservation and recovery of all kinds of landmarks.

PERSONAL.

Jas. H. Harlow, Civil and Hydraulic Engineer, 81 Wood street, Pittsburgh, Pa., has been appointed Engineer of the Monongahela Navigation Company, which corporation owns the dams on, and gives slack water to, the Monongahela River for about 90 miles.

Mr. William Rotch, formerly Chief Engineer of the Fall River Water-Works, but for the past year the purchasing agent of the A. T. & S. Fe R. R. system, now constructing the Mexican Central and Sonora Railway in Mexico, and the Atlantic & Pacific, and the California Southern in New Mexico, aggregating some 4,000 miles, to be constructed in five years, is in the city this week for the purchase of railway material and plant for these several roads. He sent on Monday, the 21st, a cargo of 1,400 tons to Guyamas, Gulf of California, for the Sonora Railroad, the week previous he dispatched a cargo to Vera Cruz for the Mexican Central, and early the coming week a cargo will leave for San Diego for the California Southern. The company are shipping by every line engines, cars, etc., for their several lines. The Chief Engineer of the California Southern Railroad, is Joseph O. Osgood, with headquarters at San Diego.

A meeting of the Mississippi River Commission, General Q. A. Gillmore, President, will take place at St. Louis, on the 23d inst. The special object of the meeting is to prepare projects of improvement for applying the one million of dollars appropriated at the last session of Congress, to be expended in executing the plans of the commission, and under its advisory supervision. Mr. Taylor, of Indianapolis, succeeds General Benjamin Harrison on the Commission.

At a meeting of the Worlds' Fair Commission, held on the 23d inst., the following communication was read:

NEW YORK CITY, March 22, 1881

GENTLEMEN: I have the honor very respectfully to tender my resignation as President of the Worlds' Fair Commission for 1883. I am satisfied that to make the enterprise a success will require the undivided time of whoever may hold the position of President. It will be impossible for me to devote any time to the duties of the office for a number of months to come, and I expect to be so engaged as to make it inconvenient to devote much time to it even at a later date. Hoping that your enterprise may meet the greatest success, I am, very truly yours, U. S. GRANT.

To the Commissioners of the World's Fair of 1883.

The resignation was accepted and the Committee on Permanent Organization was requested to report a nomination to fill the vacancy.

THE HISTORY AND STATISTICS OF AMERICAN WATER-WORKS.*

BY J. JAMES R. CROES, M. AM. SOC. C. E.

(*Continued from page* 114.)

The systematic testing of pumping-engines was first made under Mr. Kirkwood's direction, primarily to determine the availability of certain types of engines, and afterwards to determine the degree of compliance with contract requirements as to capacity and duty. The result of this has been a great improvement in pumping-engines since that time. In fact, the thorough examination and systematizing of all subjects which came under Mr. Kirkwood's observations during the construction of these works, and the full publication of the conclusions reached and the reasons for the same, gave water-works engineering in America a standing far higher than it had before reached, and led to more scientific and really economical methods of construction and operation of works of water supply.

In 1874, the gates for the new storage reservoir were fitted with hydraulic lifts. The gates are 2.5 by 3 ft. wedged, with scraped gun metal faces on the slides. They are raised by a piston attached to the gate rod, and working in a cylinder filled with alcohol. A double line of pipes connect the fluid above and below the piston. On a branch connecting these two pipes is a small circulating pump and two sets of stop valves, so arranged that by opening two and closing two diagonally the fluid may be taken from either side of the piston and placed on the other, and the piston thus be moved up or down, and with it the gate rod or gate. The gate being raised to any point by pumping is held there in place. It can be lowered in the same way by reversing the valves and working the pumps. By this method, gates 3 ft. lift and 2½ ft. wide can be raised in six minutes, without any trouble, and lowered in less than one minute, or as slowly as may be deemed necessary.

In 1878 some experiments were made on the underground water at the Hempstead reservoir. Tubes were driven about 500 ft. apart on lines at right angles to the reservoir, and also parallel to it, from above to below the dam. From the observations it would seem that a considerable body of water passes through the sand into a brook west of the reservoir.

It was further estimated that with a full reservoir the surrounding sand held a storage of 500,000,000 gallons, which was availed by drawing down the reservoir.

For the construction of the water-works a corporation called the Nassau Water Company was created, which made a contract for the whole work for $4,025,000 with a firm of contractors.

The plans and specifications were prepared by Samuel McElroy, C. E. Before the work was begun the city took up the stock of the corporation and appointed five commissioners to supervise the work. Mr. James P. Kirkwood was appointed chief engineer and Moses Lane and S. McElroy assistants. Modifications of some details of the plans were made during construction.

Afterward the management was vested in the Nassau Water Board, of three members appointed

* Copyright 1881.

by the mayor and aldermen, and in 1874 was transferred to a Board of City Works.

The chief engineers since Mr. Kirkwood have been Moses Lane, Julius W. Adams and Robert Van Buren.

The cost of the construction under the original contract as modified, was $5,284,626.21. The receipts from the beginning up to Jan. 1, 1880, had been $13,253,666.63.

For the ten years ending Jan. 1, 1880, the receipts had been $9,592,640.75, and the expenses of maintenance and repairs $2,961,931.59.

The receipts in 1880 were $1,157,000, and the cost of maintenance and repairs $272,000.

IV.—CHICAGO.

The city of Chicago, on the southerly shore of Lake Michigan, in latitude 41° 52' North and longitude 78° 35' West, was laid out in 1833; it is 591 ft. above the sea, on a plain, which was originally low and swampy, with an average elevation of 12 ft. above the lake. The highest ground in any direction within five miles of the mouth of the Chicago River, on both sides of which the city lies, is 23 ft. above the lake. Its area is 36 square miles, and there are 650 miles of streets.

In 1840, the population being 4,500, the Chicago Hydraulic Company, a private corporation, began supplying water from Lake Michigan. Their works consisted of an 18-in. inlet pipe, from a crib in the lake, for 700 ft., to a well, 15 ft. deep, where a steam pump forced the water through several miles of wooden pipe, of 2, 3 and 6-in. bore.

The superiority, sanitarily, of the water supplied by the company, over that drawn from wells, was so marked during the cholera season of 1849 and 1850 that in 1851 the Chicago City Hydraulic Company, composed of three commissioners, elected by the people, was incorporated by the Legislature.

Their works, constructed from the plans of Wm. J. McAlpine, C. E., were completed in 1854, the population being then 70,000. Water was drawn from Lake Michigan into a rectangular pump well 20 by 30 ft., and 25 ft. deep, inclosed by a stone wall 6 to 7 ft. thick. A vertical beam engine with 44-in. cylinder, with 108-in. stroke, with 2 single-acting pumps 34-in. bore, and 66-in. stroke, pumped into a stand-pipe 136 ft. high, inclosed in a square brick tower 14 ft. at the base and 11 ft. at the top, built in two divisions, one of which was used as a smoke-stack. The foundation was on sand 6 ft. below the surface. At one time during construction the tower was 14 in. out of plumb owing to irregular settlement, but was straightened before its completion. An auxiliary non-condensing engine of 18-in. cylinder and 72-in. stroke, driving a double-acting pump of the same dimensions, was used for two years.

During the first 4 months water was furnished for only 9 hours a day and none on Sundays. The distributing pipes were of cast iron. The first engine was used for 16 years.

For connecting the parts of the city on opposite sides of the river a 12-in. submerged iron pipe was laid at State street, which was broken by an anchor of a vessel, and a 30-in. pipe put in its place.

In 1856 a 24-in. wrought-iron pipe was laid across the river, a trench being dredged to 18 ft. below water-level, in which the pipe was laid and covered with 3 ft. of sand. Before this pipe came into use it was injured by a pile being driven through it and was taken up and relaid.

In 1856 52½ miles of pipe had been laid, and a new engine of 60-in. cylinder and 120-in. stroke, with two double-acting pumps of 40-in. bore and 75-in. stroke, was built.

A reservoir was built in 1854, consisting of a wrought-iron tank elevated on masonry walls. In 1858 two more reservoirs were built, on three concentric circular walls, 3 ft. thick, 9 ft. apart and 42.5 ft. high, the outer one being 62 ft. in diameter and of stone masonry—the others of brick; 9-in. wrought-iron beams were placed radiating from the centre, and 2 ft. apart at their ends, and on them rested a $\frac{1}{16}$-in. wrought-iron tank, 60 ft. in diameter and 28 ft. high, braced on the outside and tied by iron rods connected at the centre. The supply and distribution pipe entered at the bottom. Around the tank was a 12-in. air space, with wooden casing and wooden roof. The water surface was 84 ft. above the lake. In the first reservoir the walls were connected by arches, the arches resting on a masonry platform. This was found inconvenient when repairs to the bottom of the tank were required, and it was changed, in 1859, to the same plan as the others, but the beams were placed too far apart and the tank leaked badly.

In 1859 another 10-in. pipe and in 1860 a 24-in. pipe was laid across the river.

There had been, before 1860, a good deal of annoyance from the turbidity of the water drawn from the shore of the lake. Mr. E. A. Chesbrough, the Engineer to the Sewer Commissioners, was directed to examine methods of obviating this difficulty, and in his report first suggested the construction of a tunnel for a considerable distance under the lake so as to procure water from a point unaffected by the discharge from the river which was the receptacle of all the sewage of the town.

In 1861, the works were placed in control of a Board of Public Works, and Mr. Chesbrough was made City Engineer. In this year the first or south reservoir leaked very badly, which was stated to be owing to the bad quality of the English iron used in its construction. In 1862 the bottom was repaired by placing on it five coatings of roofing composition and four of felt, and over this three inches of concrete.

On March 17, 1864, the construction of the lake tunnel began. This tunnel extends from a shaft sunk near the shore of the lake to a crib inclosing a shaft two miles from the shore in the lake. Three gates allow the water to be drawn at different levels. The tunnel, which is 5 ft. wide and 5 ft. 2 in. high, lined with brick, was driven through clay about 30 ft. below the bottom. The tunnel was completed on the 25th of March, 1867, having cost $457,844.99.

In 1866 a pump well 21 ft. deep was excavated to receive the water from the tunnel. The excavation was in quicksand; a curb was built of brick masonry of 31.5 ft. inside diameter and 2¾ ft. wide at the bottom, resting on an iron shoe 2½ ft. deep, with a cutting edge. From a platform on top of this a dredging-machine was operated, removing the material from the inside of the curb, which settled by its own weight. The bottom of the well was floored with two courses of 3-in. oak plank, on which 10-in. pine timbers were placed with concrete between them and covered with a course of 3-in. oak plank and then 9 in. of concrete.

On this was built the foundation for a condensing coupled beam engine, with two cylinders of 44-in. diameter and 96-in. stroke. Under each cylinder was a double-acting pump of 28-in. stroke. The other end of the beams were coupled to a fly-wheel. These engines were of 18,000,000 gallons capacity, and pumped into a 36-in. stand-pipe 138 ft. high, inclosed in an octagonal stone tower 154 ft. high.

In 1868 another pump well was sunk, and in 1871 two vertical beam condensing engines, coupled, of 36 million gallons capacity, were built after the designs of D. C. Cregier, who has been the engineer of the pumping works from 1854 to the present time.

In 1869 one of the large submerged mains was broken by an anchor. The frequent accidents to these river mains induced the substitution for them of brick tunnels 6 ft. in diameter, in which pipes crossing the river are now laid. There were four such in use in 1870.

On Oct. 9, 1871, the great fire occurred, destroying an area of four miles long and two-thirds of a mile wide, including the pumping station. The engines were badly damaged, all wood work being destroyed, but on Oct. 17 one engine was in running order again, and the others were repaired by Nov. 10. Two of the reservoirs were badly damaged, the first or south reservoir so much so that its use was discontinued.

During the week succeeding the fire a partial supply of water was procured by pumping from wells into the mains.

A second lake tunnel was begun in 1872 and completed in 1874. The second tunnel is 7 ft. in diameter and is parallel to and 46 ft. distant from the first. A shaft was sunk in the lake near the crib, and connection made with the crib by a cross tunnel.

At the shore end the second tunnel is connected with the old, or north side, pump well and is then continued through the city for four miles, passing under the Chicago River and South Branch to the west side pumping station, there delivering the water into a pump well 44 by 10 ft., with walls of squared stone masonry founded on rock 44.5 ft. below ground surface. The water is pumped by two condensing, compound beam engines, arranged to work separately or together. The high pressure cylinders are of 48-in. diameter and 72-in. stroke, and the low pressure are of 70-in. diameter and 120-in. stroke.

Under the low pressure cylinder is a direct acting bucket and plunger pump, the chamber being of 31-in. and the plunger of 36-in. diameter with 120-in. stroke, pumping into a 5-ft. stand-pipe 167 ft. high, inclosed in an ornamental masonry tower 190 ft. high. These works were put in operation November, 1876.

In 1875 the lake crib above low water was rebuilt of stone masonry. In 1877 the centres of the sides of the crib were found to be bulged about 2 inches. Twenty-two 3-inch steel rods were put in, tying the inner and outer faces of the wood work.

The crib is subjected to great strains from the waves in storms, and from ice in winter. Masses of broken ice are sometimes piled up about it from the bottom to 20 feet above the surface of the water. The bold project of drawing the supply from a great distance by a submarine tunnel was so successfully accomplished, under the direction of Mr. Chesbrough, and its practicability so thoroughly proved, that other cities on Lake Erie have followed the example of Chicago in this respect, and in Chicago itself several tunnels have been built under the rivers for traffic.

In the first distribution system, 6 miles of 3-in. pipe were laid, but its use was discontinued after 1856, and no pipes less than 6 in. were laid except for short connections after 1876. About ten miles of 3 and 4 in. pipe have been replaced by larger sizes, and laid deeper than was at first considered necessary, great trouble having been experienced from the freezing of pipes laid 4 to 4½ ft. below the surface.

The use of meters was begun in 1860, when 12 were put in place. In 1870 530 Worthington meters were in use. Some Gem, and Ball and Fitt's meters were afterward put in.

At the time of the fire 656 meters were in, 367 of which were injured. By 1877 the number was increased to 1,623, and in 1880 to 2,000.

The use of water engines for elevators was begun in 1875, and 132 were in use by the end of 1877.

The increased head required of late years has rendered the reservoirs useless. All water is pumped into the stand pipes, and the engines are in operation all the time. The full pumping capac

ity is about 100 million gallons per day, and the consumption from 50 to 75 millions.

The population, pipeage and consumption every tenth year has been:

Year.	Population.	Miles of pipe.	Daily consumption, in millions of gallons.
1860.....	109,260	91	4.60
1870.....	298,700	272	21.77
1880.....	503,304	450	57.41

There are about 62,000 taps in use.

The Chicago City Hydraulic Company, the original organization, had control of the water-works only. The Commissioners of Public Works, from 1861 to 1876, had control of all the city works, Mr. E. S. Chesbrough being the City Engineer.

From 1877 to 1879 the Mayor was at the head of the Department of Public Works, and Mr. Chesbrough City Engineer.

In 1880 one commissioner was placed at the head of the department.

On Mr. Chesbrough's resignation, D. C. Cregier was made City Engineer.

The cost of all the works to Jan. 1, 1880, was $8,644,754, and the receipts had been $10,334,655.

(TO BE CONTINUED.)

SURVEYING, LAYING OUT AND MONUMENTING THE NEW WARDS OF NEW YORK.

BY S. S. HAIGHT, CIVIL ENGINEER AND CITY SURVEYOR, WEST FARMS, NEW YORK.*

V.

The services of Messrs. Briggs and Crosby are exclusively devoted to the preparation of maps for the Commissioners of Taxes and Assessments, upon which work others of the force are occasionally employed, and upon which all were engaged in December, 1880; the sum appropriated for monumenting during that year having been then expended. Without desiring to make invidious distinctions, special mention should be made of Messrs. Greiffenberg (whose services in the office are considered invaluable), and Fox (who has few equals as a chainman); they having been employed by the Department almost continuously since the commencement of the work.

In addition to those whose names have been mentioned, there have been employed for periods of time varying from four months to as many years, Messrs. R. L. Stuart, J. W. Barlow and F. W. Brown, as clerks; J. W. Maclay, as Principal Assistant to the Civil and Topographical Engineer; A. M. Bailey and T. Franklin, as Assistant Engineers; B. Huffnagle and H. Cruger, as Draughtsmen; Boggs, O'Brien, W. Muller, G. Washburn, G. A. Weaver, G. Penfield, G. J. Meinell, and Jennings, as Chainmen; and S. Boggs, J. H. Clabby, J. A. Dickson and E. White, as Axemen. J. D. Bradford and Wm. Henry Baldwin were Assistants of Thos. C. Cornell in doing the work of his first and second contracts, completing his third contract as members of the firm of Cornell, Bradford & Baldwin.

The list of members of the American Society of Civil Engineers contains the names of Messrs. Grant, Greene, Croes, Van Winkle, Cooke, Schott, Bonticou and Crosby; General Greene having been President, Mr. Croes now being Treasurer, and Messrs. Croes and Van Winkle members of the Board of Direction.

Of those whose service in the department has ceased, two were graduates of West Point (where General Greene was for a time professor of mathematics); one, of St. James College, Maryland; two, of the Rensselaer Polytechnic Institute; one, of the College of the City of New York (where Mr. Hollerith is now engaged as tutor); one, of Trinity College, Dublin; and one (the son of the present Secretary of the Navy), of Yale College. An undergraduate of Swarthmore College was also employed for a short time. Others may have been graduates without the writer's knowledge. Of the present force, Messrs. Van Winkle and Rogers graduated at Union College; Mr. Greiffenberg at the Polytechnic School at Carlsruhe, Germany; and Messrs. Vogel and Hoag at the College of the City of New York, of which Mr. Graham is an undergraduate. Mr. Buckalew is an undergraduate of Rutgers College, and Mr. Mehles of the Polytechnic School at Cologne, Germany. During the early years of this work much labor was bestowed upon plans that have been (or may yet be) changed or abolished.

Of these the proposed tunnel under the Harlem River at Seventh avenue may be mentioned, of which elaborate plans were prepared after careful surveys and soundings had been made, and the lines staked under Mr. Grant's direction.

Nearly all the necessary steps were taken, also under Mr. Grant, preliminary to beginning the construction of a suspension bridge across the Harlem River, a little north of High Bridge.

After much study and calculation of estimates of quantities in grading, and of its cost, a site was selected at Inwood for a parade ground.

Its corners and the lines of adjoining streets were monumented, and maps were filed in accordance with a special act of the Legislature, which a succeeding Legislature repealed. All work upon it was done during Mr. Grant's administration.

The triangulation survey of the Harlem River was a work of time, requiring great care; and much time and study were bestowed upon matters of drainage and upon devising the proper routes for rapid transit so that no street crossing should be at grade.

Though the plans adopted for streets and avenues are not in all cases the best that could be devised, they are considered to be generally the most practicable, and have received the approval of a large majority of the land owners most deeply interested.

After the maps are filed and the monuments are set, many years may pass before most of the streets will be opened; yet the land owners have it in their power to ascertain the lines and grades, and will be likely to conform thereto in all valuable improvements that they make.

The subdivisions that will be made in placing land upon the market will be generally based upon these new lines, and in the course of time many of the streets will be opened by the owners of the property, even if the city takes no further steps leading thereto.

Some of the avenues that will probably be main lines of travel, and those that are especially required to be opened for drainage purposes, will undoubtedly be soon opened by the city, the preliminary steps for such opening having been already taken in numerous instances.

A statement on page 96 should be corrected; the writer having been assured that the transfer of Mr. Grant from the bureau of civil and topographical engineering, to that of construction, was made in compliance with his own choice.

The topographical surveys had then been completed, and the maps made, while plans had been prepared for nearly the whole territory, and it seemed probable that thereafter the work under charge of the engineer of construction would be much the most important.

The writer's authority for the statement made on page 96 was the late Robert L. Cooke, who mentioned a warning received by him from the person there alluded to, in these words: "Mr. Grant did not understand my position, and I had him removed." It is pleasant to find that his influence for evil was less than he supposed.

The words inclosed by brackets, mentioning Mr. Grant's transfer, should have been at the end of the sentence, instead of in the middle.

Any other errors that may be discovered in this history will be cheerfully corrected when made known, and the writer will be thankful for having his attention drawn thereto.

* Correction: On page 103, the "to" should be omitted from the top line of the marginal note, so as to read, "introduced in the Legislature" instead of "into."

On the last line of the fourth paragraph, above the bottom of the third column, the first letter of "Tremont" has been wrongly printed "F."

The "1" should be omitted from the first name at top of page 104, the name being "Effingham M. Cock." "Placed" should have been used instead of "sets," so as to read "placed points that have been connected," etc.

On page 92, in upper line of fifth paragraph from bottom of middle column, "were" should be "was," so as to read "a set of standard rods was made."

On page 96, ninth line from bottom of first column, "Mill Brook sewage" should have been "Mill Brook sewerage."

CORRESPONDENCE.

PROBLEM IN R. R. CURVES.

N. & F. R. R., MT. PLEASANT, Tenn., March 17, 1881.

Answer to problem in R. R. curves, ENGINEERING NEWS, March 5, 1881, L. E. Vel.:

t = tangent 2° curve; t' = tan. 1° curve.

R = radius 2° curve $= \frac{50}{\text{sin. } 1°}$

R' = rad. 1° curve $= \frac{50}{\text{sin. } 30'}$

$t = R \tan. 20°$; $t' = R' \tan. 10°$

$AC - t : t + t' = \text{sin. } 20° : \text{sin. } (120° \text{ or } 60°)$

$AC - t = (t + t') \frac{\text{sin. } 20°}{\text{sin. } 60°}$

$AC = t + (t + t') \frac{\text{sin. } 20°}{\text{sin. } 60°}$

Respectfully, C. W. BROWN, Chief Engineer.

RENSSELAER POLYTECHNIC INSTITUTE.

EDITOR ENGINEERING NEWS:

I was much interested in your late remarks on the Rensselaer Polytechnic Institute of Troy. Now, in view of the straitened circumstances of this seat of learning, its well-earned reputation and financial distress, perhaps a suggestion might be in place, it is, to consolidate it with the Lehigh University of Bethlehem, Pa., which possesses a wealthy endowment of about $3,000,000, from the benevolent Asa Packer. This university is young in years and experience, is building up an enviable reputation for *thoroughness;* is located in a region famous for its railroads and manufacturing enterprises, and rich in iron and coal mines. By jointly making a specialty of technical studies, they would, hand in hand, with a rich experience and unlimited wealth, offer to the American student advantages unequalled on this continent, and make it the peer of any European university. FULTON.

THE PHILADELPHIA WATER-WORKS, ETC.

EDITOR ENGINEERING NEWS:

In the last number of ENGINEERING NEWS it is stated that the Wentz Farm Reservoir in this city leaked through the bottom after construction, in consequence of the construction stakes having made holes in the puddle bottom. I was the engineer who set the stakes, and I beg to submit the opinion that they were not at fault. In ordering the stakes, which were nicely made at the department shop, I had them purposely made shorter than the depth of the puddle, so that they should not go through. The puddle was two feet thick, and my recollection is that the stakes were fifteen inches long. The order giving the length is still no doubt preserved in the department letter book, but I have no longer access to it. The leakage, however, was a very small matter, only discoverable by some springs appearing at a short distance from the reservoir, and has been stopping itself. It seems to me that if it teaches a lesson, it is that a puddle bottom to sustain a head of 23 feet of water resting on a micaceous sand had better be more than two feet thick. The puddle in the sides of the same reservoir is four feet thick, and has never leaked a drop. After the leakage appeared, the water was drawn off and the bottom examined. Very small holes were found in the puddle at many places, but they were

not at equal distances of fifty feet apart, as they should have been had they been caused by the stakes. One fact that, no doubt, gave rise to the idea of the stakes causing the leaks, was that the examination showed that the largest hole in the bottom was caused by a large wooden post that had been used as an anchorage for a guy-rope of the derrick used in the construction of the stop-house, and which did go through the puddle, and had been still in use when the puddle was placed around it, and had been afterwards cut off.

To refer to another subject in the same paper, while fully agreeing with Mr. Searles in his views of logarithms as a labor-saving device, I beg to submit that perhaps a simpler method of solving Mr. Vel's problem consists in calculating one side of the triangle formed by the common tangent at the point of compound curvature with the produced tangent at the point of curve and point of tangent, and then adding the tangent distance of one of the curves. This expressed by a formula is

$$x = \frac{\sin 20^\circ}{\sin 60^\circ}(2865 \tan. 20^\circ + 5730 \tan. 10^\circ) + 2865$$
$$\tan. 20^\circ = 1853.6.$$

Very truly yours,

THOS. M. CLEEMANN.

P. S.—I was sorry to see that in your report of those present at Mr. Potter's house you put me as being of the class of 1845 of the Rens. Pol. Inst. I am not quite so old a fellow as that. I graduated in 1865, twenty years after! T. M. C.

ENGINEERS' SOCIETIES.

BOSTON SOCIETY OF CIVIL ENGINEERS.

The annual meeting of the Boston Society of Civil Engineers was held on Wednesday, March 16, and the following officers were elected for the ensuing year: President, Thomas Doane; Vice-President, Edward S. Philbrick: Secretary, S. Everett Tinkham; Treasurer, Henry Manley; Librarian, Fred. Brooks; Auditor, Wm. H. Bradley.

ENGINEERING IN FOREIGN LANDS.

(Translated and prepared for ENGINEERING NEWS).

THE ANTWERP DOCKS.

M. Hersent, one of the contractors for the construction of the Panama Canal, gave some interesting details of his work on the Antwerp docks before a recent meeting of the *Société des Ingenieurs Civils* of Paris. There has been hitherto a great inferiority in the system of French docks, and this is now apparent in the immense strides which the commerce of Antwerp has taken. The tonnage of different continental ports in 1879 was as follows: Antwerp, 5,674,243 tons; Marseilles, 2,591,052; Genoa, 2,068,973; Havre, 1,888,099; Bordeaux, 871,930; Dunkirk, 726,401; and Rouen, 582,951. Genoa owes its recent revival to improved docks, but with the exception of Dunkirk, there is no French port where the docks allow an easy movement of cars and vessels. The Marseilles docks are rectangular, and the railroad cars have to be turned on turnstiles, which causes considerable delay. Antwerp has its railroad termini so disposed that a transatlantic steamer finds 150 cars alongside waiting to receive its cargo. When it was decided to rebuild the quays, the figures given by the contractors were so high that no award was made. Afterward, however, a contract was signed with Couvreux and Hersent for building 3½ kilometers of quays for 38,275,000 francs. The wall was to be paid for extra when foundations were beyond a certain limit. A lock for the boat dock was made in the very bed of the Scheldt by a caisson of 43×23 meters, divided into five chambers of 8 meters, in each of which the excavation, and filling in with beton were executed by compressed air. The work was done without a coffer dam in the bed of the river. The quay walls are 14m. 35 height, with an additional average of 9m. 70 for foundation. The thickness is 9 meters for the foundation; 7 meters for the part immediately above the foundation, and 6m. 30 for low tide level. The walls as well as the lock were built in the bed of the river by compressed air, with the aid of metallic caissons, 25×9 meters. Each working caisson is surmounted by a coffer dam, and the joint is made tight by a strip of India-rubber. The whole is topped by a floating scaffolding resting on two boats, one on each side of the caisson. The boats contain steam engines for the air pumps, mortar machines and the apparatus of the coffer dam.

When the caisson is afloat, surmounted by the coffer dam, and with the floating scaffolding alongside, it is brought to the required place and sunk. Floating is hindered, if necessary, by water ballast in the coffer dam. Caissons have been sunk with only a difference of ten centimeters at the maximum.

Owing to the silty nature of the bottom it is usual to face the embankment with alluvial deposits, which have been found effectual in resisting the currents. The pressure of the bêton per square centimeter is nearly two kilogrammes. The French ports are under government control, and the spirit of routine is such that all offers of engineers to improve them have been rejected.

BRAZIL.

The municipal authorities of Rio Claro will contract a loan of $50,000 for the construction of water-works and a public fountain.

A commission of engineers, appointed by the Alto Muriahé railroad company have left for Alto Muriahé to determine the zone through which that railroad is to pass.

According to the estimates of Dr. Luiz Antonio Monteiro de Barros, who was recently invited by the president of Pernambuco to examine the water supply of that city with reference to its increase, it will cost a further expenditure of 1,613,700$ to secure a total daily supply of 10,000 cubic meters of water. The present supply is 6,000 cubic meters.

The minister of agriculture has instructed the engineer, Mr. Milnor Roberts, to examine the ports of Victoria and Benevente in order to ascertain which of them is most convenient as a starting point for the Espirito Santo railway.

The minister of agriculture has resolved to direct an engineer to examine the plans of two projected railroads in the province of Sergipe in order to ascertain which of them ought to receive the guarantee of interest on the part of the government.

A letter from Caravellas says that 100 kilometers of the "Caravellas a Philadelphia" line have been explored, 20 kilometers have been located, and 8 kilometers have been cleared.

The president of Minas Geraes has signed a contract with Dr. Candido José Coelho de Moura for the construction of a railway between S. Joao d'El-Rey and Oliveira.

BÉTON COFFER-DAM.

The *Annales des Ponts et Chaussées* says that M. Bernard, who has charge of the harbor improvements in Marseilles, has given an interesting account of the construction of a coffer-dam in the National Dock. It was built about an elevated rock so as to remove the surrounding rocky mass, and separated some 4 hectares 35 ares from the sea. Its extent was 1,069 meters and had to bear 7 meter 80 at high tide. Some 13,500 cubic meters of excavation had to be removed; 37,500 meters of béton were sunk, composed of teil lime and sea sand, in the respective proportions of 400 kilos to 1m. 07. The total expense was 1,200,000 francs.

ROME.

In expectation of the passage of the bill now before the Chambers for a Government loan of $1,000,000 to the City of Rome for public improvements, the following plans have been approved: The construction of a Palace of Justice, an Academy of Sciences, a Polytechnic School, two barracks, a military hospital, a Champs de Mars, two bridges over the Tiber, a system of drainage, central market, and a continuation of the Via Natzionale.

The demolition of the Ghetto or Hebrew quarter, and the construction of new Houses of Parliament are accepted in principal, and also an increase in the water supply for manufacturing purposes, but these plans have been deferred.

SUEZ CANAL.

The traffic returns of the Suez Canal from the 1st to the 28th of February were 3,290,000 francs, against 3,267,754 francs in 1880. The total receipts for the two months were 7,797,680 francs, against 7,069,933 francs in 1880.

Water-works are to be built this season at New Castle, Penna., by a company of Pittsburgh capitalists. The engineer of the works is Mr. Jas. H. Harlow, Mem. A. S. C. E. and Sec'y Eng. So. of West. Penna., 81 Wood St., Pittsburgh, formerly engaged on the Davis Island Dam Improvement under Col. Wm. E. Merrill, U. S. Eng., but now in business for himself at the above address.

STEEL: ITS COMPOSITION AND PROPERTIES.

On Tuesday evening, Feb. 3, A. K. Huntington, Esq., Professor of Metallurgy, King's College, London, Eng., delivered the following lecture at the hall of the London Cutlers' Company, before a large audience, the Master Cutler presiding:

In addressing you this evening it will be my aim to bring before you some of the more important facts in connection with the mode of production of steel, so far as they are at present understood. Considering the immense advance which science has made within recent years, and the national importance of the manufacture of steel, it is at first sight a little surprising how very limited our scientific knowledge of the subject is. The knowledge we do possess is, to a great extent, empirical, *i. e.*, the outcome of direct experiments in each particular case. We have not yet a sufficiency of carefully ascertained facts to enable us to draw correct conclusions regarding many important phenomena; we only know that they occur. It is a great step in advance that all works of any importance now employ an analyst. Still these men are generally too much engaged in carrying on the routine work of the establishment to give time to investigations which may require months or even years of carefully thought-out work before a result of practical value is arrived at. And, further, the very nature of metallurgical processes is a stumbling-block in the way of investigations. The majority of experiments, to be of any use, must be made on a large scale, and metallurgical experiments on a large scale are costly. We cannot be astonished that manufacturers are slow to embark their capital in experiments the results of which are altogether uncertain. In working out a new process hundreds of unforeseen difficulties arise, and they are rarely overcome by the genius of one man. A successful process usually results from the combined ideas of many workers, each one modifying or extending the work of those who came before. It results from this that progress in the arts is more often made by modifying old processes as opportunity presents—say when repairing or entirely rebuilding—than by the introduction of methods requiring apparatus of a totally new kind. Metallurgical processes, based on an entirely new principle, usually require years to develop and become commercially successful. This is mainly due to the difficulty in suiting the mechanical arrangements to the chemical requirements of the method. Many processes have produced excellent iron or steel, but only at ruinous expense for machinery and labor, two items commonly overlooked or much underrated by inventors. Good steel has been produced from time immemorial, and it might well be asked what more do we want than that? Why trouble about the principle of the process? What does it matter how the result is obtained so long as we have no difficulty in obtaining it? The answer is that it is one thing to produce good steel and another to produce it economically. The tendency of scientific knowledge is to cheapen production, and, as a consequence, to proportionately extend the applications of the product. We can take no better example of this than the Bessemer process. It was scientific in its conception and altogether different from anything ever attempted before. The *rationale* of the process is in no way different from that of all other methods for the production of malleable iron from cast iron, namely, the elimination of the carbon of the cast iron as carbonic acid and carbonic oxide by means of oxygen. The value of the method depends, then, on the cheapness with which sufficiently good steel can be produced, and not on the capability of the process to yield a better quality than has previously been obtained by other methods. There is but one important drawback in the Bessemer process, and that is that it does not eliminate phosphorus, a substance which greatly impairs the working qualities of steel, and which is present in more or less quantity in the majority of iron ores. The consequence is that the expense of this process is somewhat greater than it would otherwise be, as ores practically free from phosphorus alone can be used. Nevertheless, this process has enormously cheapened the production of steel and extended its application. A recent process, which is a modification of the Bessemer process—a step further in advance—has enabled us to make good steel even from iron ore containing the largest quantity of phosphorus. Popular prejudices and ignorance of the principles of chemistry have caused it to be stated that good steel could only be produced by employing ore of superior quality. This has at last been practically demonstrated to be altogether untrue. It might equally well have

been said that good gold could not be produced from auriferous ore containing antimony, because antimony passes into gold in the process of extraction from the ore, and makes the gold brittle and useless; yet the science of chemistry has devised an economical method by means of which gold can be refined, the antimony being entirely removed, as well as other objectionable impurities, such as arsenic, bismuth, lead, and zinc; silver is also removed. The agent in this case is the gas chlorine, which is passed by means of a tube into the molten gold. The impurities are converted into chlorides, the gold remaining in the metallic state. The temperature employed causes the chlorides of antimony, arsenic, bismuth, and lead to volatilize. The chloride of silver remains as a solid, and can be readily separated from the gold. I have given this instance because antimony is commonly present in Australian gold, and one part of antimony is sufficient to injure the malleability of 2,000 parts of otherwise fine gold. The case of phosphorus and steel is analogous to that I have just given you. If good gold can be produced from impure ore, why should not good steel be also obtainable from ore containing impurities? There is no reason why it should not be so, yet many have a strong prejudice against steel which has been made from more or less impure ore, and, in the case of cutlery and edge-tools, even against steel made from pure ore, if it had been produced by modern methods; which, I may remark, yield steel equal, if not superior, to that obtainable by any older process, provided always that in both cases an equal amount of care be bestowed on the manufacture. Sir Henry Bessemer, in his able lecture, described to you the older methods of producing steel. I propose now to describe to you, briefly, the various stages of the modern methods of manufacture which result in the production of steel, taking, as an example, the practice in the Cleveland district. We will take first the production of steel in the Bessemer or acid converter. The ore used is a rich and pure peroxide of iron, obtained from Spain, Italy, and Cumberland for the most part, and containing about 50 per cent. iron. These ores are smelted in the blast-furnace with sufficient limestone and good oven coke. All iron ores are compounds of iron with oxygen, and the object of the process in the blast-furnace is to remove the oxygen in combination with the carbon of which the coke is composed. Coke is the cheapest and, at the same time, the most efficient reducing agent which could be used, and limestone is the most suitable agent for fluxing off, *i. e.*, rendering fluid the earthy part of the ore. The product of the blast-furnace is pig or cast-iron, and this, when made for the Bessemer process, contains always about the maximum quantity of carbon which iron is capable of taking up in the blast-furnace, say 3 to 3½ per cent. There will also be present in this iron from 1½ to 2¾ per cent. silicon, derived from the earthy matter of the ore, and some sulphur, as well as nearly all the phosphorus, however little may have been originally in the ore. The blast-furnace is a tall cylindrical chamber, say 70 to 80 ft. high, and about 14 ft. near the mouth; it generally widens down to the part termed the "boshes," which might measure say from 18 to 20 ft. Below this point it narrows for a certain distance, and then is continued vertically down, forming the crucible in which the metal collects. At intervals around the furnace, at the top of the crucible, are inserted tuyeres, some five or six in number, to convey the blast of air which is requisite to carry on the reactions in the furnace. The blast is usually employed at about 4½ lbs. per sq. in. pressure, and heated to about 1,000° F. The top of the furnace is covered in by an arrangement of a cup and and cone, so that, except when fresh material is being charged, the top of the furnace is closed in, with the exception of a pipe, which leads off just below the cup and cone, and conveys the waste gases away to large mains, whence they can be drawn off at will for heating the blast or engine boilers, for these gases as they issue from the blast-furnace contain much carbonic oxide gas, and only require a proper amount of air in order to enable them to burn and give out much heat. It is not many years since these gases were allowed to burn at the top of the furnaces instead of being collected and utilized. For a long time people argued that collecting the gases deranged the working of the furnace; it is, however, now universally done, and has resulted in great economy of fuel. Now let us consider what happens to the ore as it passes down through the furnace. The ore, before it has reached more than about 12 ft. down, becomes considerably heated by the hot ascending gases, and, coming in contact with the carbonic oxide which I have told you is contained in these gases, it is at once deprived of its oxygen—metallic iron and carbonic acid being formed. Another part of the ore is reduced by the direct action of the carbon of the coke on the oxygen of the ore, with formation of carbonic acid. The iron thus liberated gradually passes down through the furnace more or less mixed with carbon, and at last arrives at the zone of fusion, *i. e.*, the region where the direct action of the blast is giving rise to a very high temperature. Here the iron becomes fused, and dissolves the carbon which previously had only been mechanically mixed with it. The fused metal settles down into the crucible of the furnace, and, when sufficient has accumulated, it is tapped out through a hole near the bottom. We must now return to the top of the furnace, and trace briefly what has happened to the limestone which was introduced there with the ore and coke. Firstly, then, the limestone, which is a compound of carbonate acid with what is familiarly known as quicklime, or scientifically as oxide of the metal calcium, on becoming heated parts with its carbonic acid and any moisture it may contain, and at the same time that the carbon of the coke removes the oxygen from the iron ore the quicklime combines with the earthy matter, and forms a substance which is fluid at the temperature of the furnace, and which is technically known as slag. This slag passes down with the reduced iron and accumulates in the crucible above the metal, where it serves a useful purpose in protecting the metal from the action of the blast, which would otherwise deteriorate the quality of the metal by oxidizing it. During the process the slag runs out continuously through a hole a little above the metal. This slag is in some works being used to make cements and bricks, for which purpose it answers very well; but usually it is considered a waste product, and is disposed of accordingly. There are many points in connection with blast-furnaces which time will not allow me to more than mention now. For instance, the height and shape of blast-furnaces are very important matters; they are dependent, to a great extent, on the general nature of the ores to be dealt with, *i.e.*, whether they are heavy or light, dense or porous, etc. The character of the pig iron produced is regulated by adjusting the relative proportions of ore and limestone to one another and to the coke, and also by altering the amount of the blast of air as well as the temperature and pressure of the blast. I have said the metal is tapped out; it is often run into a bed of sand, arranged so as to obtain the metal in bars or pigs, as they are called, weighing about ¼ cwt., and which are subsequently used for making castings, remelted and converted into malleable iron in the puddling-furnace or into steel in the converter; sometimes, however, the metal is tapped straight from the blast-furnace into a big ladle, and taken thence by an engine to the converter to be made into steel. Let us consider for a moment what is necessary in order that cast-iron may yield steel through the medium of the converter. We have seen that cast-iron contains about the maximum amount of carbon possible. Malleable iron, on the other hand, contains the mimimum amount of carbon; there never can be more than a trace in it, otherwise it would not constitute malleable iron. Steel occupies an intermediate position: according to the amount of carbon it contains so will it approach in its properties malleable iron on the one hand, and cast-iron on the other. In considering the propertics of steel in relation to the amount of carbon it contains, it is necessary, however, to take into consideration the effect which manganese, sulphur, silicon and phosphorus have according to the relative proportions in which they exist in the metal. The primary object, then, of the process carried on in the converter is to reduce the amount of carbon in the metal as it is received from the blast-furnace. As a rule, in practice it is found more convenient to remove the carbon entirely, and then add the exact quantity necessary to produce the quality of metal desired. The process in the converter is, in one sense, just the reverse of that in the blast-furnace. In the latter the iron is in combination with oxygen, and the oxygen is removed by means of carbon; in the former the iron is in combination with carbon, which is removed by oxygen. The oxygen is supplied by a blast of air forced through the molten metal. The silicon is also oxidized by the blast, and converted into silica—a substance identical in composition with common sand or flint—and thus separated from the metal. The converter is a retort-shaped vessel, so arranged that by suitable machinery it can be revolved about its center to facilitate the running in the molten pig-iron and discharging the contents on the completion of the process. At the bottom of the converter is an air-chamber in connection with the blast-main, and communicating with a series of narrow channels which open into the converter. Through these openings the blast of air is forced under great pressure. The pressure of the blast must be not only sufficient to support the column of liquid metal, but to overcome its resistance and force through it. The converter is canted over on to its side, and the molten cast-iron runs in; the blast is then turned on, and the converter placed in an upright position. The roaring of the blast, the rush of white-hot flame from the mouth of the converter, occasionally accompanied by slag, which is projected far into the air, and falls in a golden shower, varied with scintillating particles of burning iron, are very impressive to witness, especially at night, when the dark shadows around lend additional grandeur to the scene. In order to modify the reaction in the converter and prevent its becoming too hot—which would cause silicon to be only partially removed—scrap steel or iron is thrown into the converter in sufficient quantity to lower the temperature to the right point; the quantity required will depend on the nature of the pig-iron being treated. The same result is sometimes arrived at by mixing different qualities of pig instead of adding scrap. The point at which the iron is sufficiently or entirely decarbonized is judged of by the appearance of the flame: it "drops" when the carbon is all burnt out. This happens usually in about 20 minutes. Supposing the course, general in England has been pursued—*i. e.*, total decarbonization of the metal—a known quantity of molten pig-iron, called speigel, containing a known quantity of manganese and carbon, is added in order to produce steel of the required degree of hardness. So soon as the speigel has been added, the steel is poured from the converter into a big ladle, having a hole at the bottom which can be closed by means of a refractory plug passing down through the metal, and worked by a lever outside. From the ladle the steel is run into large ingot-moulds. The ingot-molds are subsequently reheated in a reverberatory furnace—*i. e.*, a furnace, the bed of which is heated by flame generated in a separate chamber, no fuel coming in contact with the metal. They are then rolled out into pieces of any required form or size. Unless ore of exceptional purity were employed, steel could not be produced in the converter; without manganese, it neutralizes and partially removes impurities which would otherwise be injurious. Hence the reason speigeleisen is used instead of ordinary cast-iron to impart the necessary carbon to the iron. I have told you that phosphorus is not in the least degree removed in the Bessemer process; let us see the reason why. The cause is traceable to the lining, which is of silica; it consists of a silicious material called gannister. Let us suppose that the blast of air is passing through the molten metal; the phosphorus is immediately converted into phosphoric acid, which, combining with oxide of iron, forms phosphate of iron. If silica be present, phosphate of iron is decomposed, silicate of iron being formed, and the phosphorus passes back into the metal again. In order, then, to remove phosphorus from the metal in the converter, free silica must not be present. Many of you, doubtless, will be asking yourselves why is silica used to line the converter if it has this objectionable property. The reason is a very simple one: it is because up to quite recently no other substance was known with which a lining could be formed which would resist the high temperature in the converter without either cracking to pieces or melting. This brings us to a recent and very important modification of the Bessemer process, known as the basic process. It consists in substituting for the silicious or acid lining, as it is called, a lining composed of a substance which has not the power to prevent phosphorus from passing from the metal into the slag, and which possesses the other requisite properties I have referred to. This material is magnesian limestone. The lime, instead of combining with the oxide of iron and liberating phosphoric acid, as in the case of silica, at the most only combines with phosphoric acid, setting free oxide of iron, but keeping the phosphorus in the slag. We have at last, then, triumphed over the arch-enemy of steel—phosphorus. It all seems delightfully simple now, and the principle can be stated in half-a-dozen words; yet, simple as it seems, it has required two years' hard work on the part of hundreds of willing minds and hands to render this process a commercial success, as there appears every reason to believe it now is. Every credit is due to those who, in spite of many failures, have brought this process to a successful issue. Its value will probably be better appreciated a few years hence than it is now. The year in which it became possible to produce good steel economically from ore containing much phosphorus will come to be

looked upon as one of the most important in the annals of steel-making. Let us now refresh our memories as to the impurities which exist in the metal as it issues from the blast-furnace, and then see what remains of them in the steel from the converter. In pig-iron the usual substances other than iron ore are phosphorus, silicon, carbon, sulphur and manganese. Of these the phosphorus probably oxidizes first, and passes into the slag; but the subsequent formation of carbonic oxide during the removal of the carbon causes the phosphoric acid previously formed to be reduced, and the phosphorus to pass into the metal again, so that the phosphorus is not finally removed from the metal until all the carbon has been burnt out. Practically silicon is the first impurity removed by the action of the blast; it is converted into silica and passes into the slag, uniting with lime or oxide of iron. The next to go is carbon, passing off as carbonic acid gas, which burns at the mouth of the converter. Then the phosphorus is got rid of into the slag as phosphoric acid. Lastly, sulphur and manganese are removed, but only partially, generally about half. If the blowing were continued longer, more sulphur and manganese could be removed, but much iron would be wasted by oxidations. The impurities commence to be removed in the order I have given, but it should be understood that each impurity begins to go out before that preceding it in the list is entirely removed. In fact, in practice none of the impurities ever are entirely removed; there always remains a trace of each. There are often insuperable difficulties in removing last traces. Nevertheless, the quantity remaining can be so far reduced as to be harmless. Let us suppose the metals as taken from the blast-furnace contained in every 100 parts:

Iron	93.38
Carbon (combined)	3.40
Silicon	1.30
Phosphorus	1.80
Sulphur	.07
Manganese	.05
Total	100.00

Then, in the steel produced, there might be, say, 0.05 silicon, 0.05 phosphorus and 0.03 sulphur. The carbon and manganese depend on the amount of spiegel added, and the former at least is perfectly under control, so that the important impurities in the cast-iron have been reduced, all taken together, to 0.13 per cent. of the steel—an amount altogether harmless, at least for most purposes. We have here been supposing that a suitable metal has been obtained from the blast-furnace, and that the process in the converter has been satisfactorily carried out; were it otherwise, one or other of the impurities named might pass into the steel in greater quantity than that we have supposed. The latter state of things might very well occur, and yet good steel result, provided always that the other foreign substances and the carbon were present in suitable proportions. It has become customary, at least in this country, to call steel all the metal produced in the converter, no matter whether it can be hardened and tempered or not. Much confusion has arisen in this matter of nomenclature recently; time will not permit me to discuss the question now. In the converter a metal which will practically not harden at all can be produced equally well as a very hard steel. It is simply a matter of degree, dependent on the amount of carbon introduced at the final stage. Scarcely any hardening by plunging red-hot into cold water is produced by the presence of 0.10 per cent. carbon in the absence of manganese, phosphorus, silicon, or sulphur, for each of these assists in causing hardening. As the carbon is gradually increased, the hardening produced by sudden cooling from a red heat becomes more and more marked. A steel containing 1 per cent. is very hard and brittle; beyond this point steel gets more and more difficult to work, and at about 2 per cent. carbon it ceases to be malleable. Steel containing 0.1 per cent. carbon is much used for ship plates and angles. It welds well. Such metal will resist a strain of about 26 tons to the square inch, and will elongate 25 to 30 per cent. in a length of 8 inches before breaking. For boiler-plates, steel containing about ¼ per cent. carbon is used; it has a mean resistance to a pulling force of about 30 tons per square inch, and will weld, though not so easily as that used for ship-plates. For steel rails the carbon may vary between ¼ and ½ per cent., according to the specification of the buyer. For cold climates the lower percentage of carbon is preferred; 0.35 to 0.4 per cent. is the more general quantity for rails. The tensile strength will now be about 40 tons per square inch, and the elongation on a test-piece 8 inches long only 10 per cent. Cutlery and tool steel varies between about ¾ and 1½ per cent. carbon, the tensile strength or resistance to a traction force increasing to, say, 70 per cent., and elongation going down to 1 or 2 per cent. As the carbon is increased the fusing point is correspondingly lowered, and it is consequently necessary to regulate the temperature at which the metal is worked accordingly. The soft steels have to be worked at a white heat, but those containing much carbon must be worked at a low heat. I have already referred to the importance of manganese in the production of steel. It counteracts red-shortness, *i. e.*, brittleness, when the metal is at a red heat. It acts principally by reason of its affinity for oxygen and silicon, with which it combines, forming a fluid slag. Both these substances tend to produce red-shortness. A fluid slag is also beneficial, as it readily separates from the metal and assists in producing sound steel. The presence of ½ to 1 per cent. of manganese is often beneficial in steel, especially if sulphur is present. Silicon should be kept low in steel intended to be forged, as it produces both cold-shortness and red-shortness. This effect is, however, curiously enough, only produced when carbon is present. Steel containing less than 0.1 per cent. carbon is not very brittle, even with 0.5 per cent. of silicon; 0.2 per cent. silicon in a rail containing about 0.4 per cent. carbon would be decidedly objectionable. In cast steel the presence of silicon is very useful; it causes steel to cast solid and be free from honeycomb, and, after annealing, such steel has considerable strength. Sulphur is a very objectionable impurity in steel which has to be rolled; it produces red-shortness, and less than 0.1 per cent. will often prevent a rail from being rolled sound. In cutlery and tool steel it is not so objectionable, as it has not the property of inducing brittleness. Its presence in castings causes unsoundness. Phosphorus, unlike sulphur, produces cold-shortness; when both are present one, to a certain extent, counteracts the other. Phosphorus produces hardness even more than carbon, 1 per cent. phosphorus having an effect equal to 2 to 3 per cent. of carbon. As in the case of silicon, the brittleness seems to depend on carbon being present. If carbon be absent, 0.2 per cent. phosphorus will not produce marked brittleness in a rail; but if there be about 0.4 per cent. carbon, then 0.1 per cent phosphorus would cause very decided brittleness. Steel intended for cutlery or tools should be very free from phosphorus, otherwise it cannot be properly tempered, and the presence of 0.03 phosphorus prevents the production of a good cutting edge. A little phosphorus in cast steel is advantageous, as it makes the metal more fluid, and, consequently, it takes the mold thoroughly, and gives a sound casting. You are now in a position to realize the importance of a scientific knowledge of the art of manufacturing steel, since such minute quantities produce such very marked effects, each one modifying, to some extent, the effect of each other. Had time permitted, I should have wished to have given you an account of another modern process, by means of which much good steel is produced in an open hearth of a reverberating furnace. It is called the Siemens-Martin process. Instead of the carbon being removed by means of a blast of air, it is got rid of by the addition of oxide of iron, in the form of iron ore, and scrap iron to the molten pig-iron. By means of the Siemens regenerative gas furnace sufficient heat is obtained to keep the steel, no matter how soft, in a molten state. Spiegeleisen is used in the production of this steel, as in the converter process.

THE RIVER AND HARBOR APPROPRIATION.

AN ACT making appropriations for the construction, completion, repair, and preservation of certain works on rivers and harbors, and for other purposes.

Be it enacted by the Senate and House of Representatives of the United States of America in Congress assembled, That the following sums of money be, and are hereby appropriated to be paid out of any money in the Treasury not otherwise appropriated, and to be expended under the direction of the Secretary of War, for the construction, completion, repair, and preservation of the public works hereinafter named:

Improving Richmond Island and Harbor, Maine: Completing improvement three thousand dollars.

Improving harbor at Portsmouth, New Hampshire, twenty thousand dollars.

Improving harbor at Burlington, Vermont, ten thousand dollars.

Improving harbor at Swanton, Vermont, two thousand five hundred dollars.

Improving harbor at Hyannis, Massachusetts: Completing improvement, five thousand dollars.

Improving harbor at Newburyport, Massachusetts, forty thousand dollars.

Improving harbor at Nantucket, Massachusetts, twenty-five thousand dollars.

Improving harbor at Plymouth, Massachusetts, ten thousand dollars.

Improving harbor at Provincetown, Massachusetts, five thousand dollars.

Improving Little Narragansett Bay, Rhode Island, five thousand dollars.

Improving harbor at Bridgeport, Connecticut, ten thousand dollars.

Improving harbor at New Haven, Connecticut, fifteen thousand dollars.

Breakwater at New Haven, Connecticut, sixty thousand dollars.

Improving harbor at Norwalk, Connecticut, five thousand dollars.

Improving harbor at Southport, Connecticut, two thousand five hundred dollars.

Improving harbor at Boston, Massachusetts, one hundred thousand dollars; of which sum forty thousand dollars shall be expended in said harbor, thirty-five thousand dollars at the mouth of Charles River in said harbor and up to Watertown, twenty thousand dollars in said harbor at mouth of Mystic River, and five thousand dollars from said harbor to Nantasket Beach.

Improving Oakland Harbor, California, sixty thousand dollars; and the sums of money heretofore appropriated for this improvement and unexpended are hereby reappropriated; but the sums so appropriated and reappropriated shall not be available until the right of the United States to the bed of the estuary and training walls of this work is secured, free of expense to the government, in a manner satisfactory to the Secretary of War.

Improving Raritan River, New Jersey, twenty-five thousand dollars; of which sum twenty thousand dollars shall be expended on rocks at Whitehead Sand Dock, and five thousand dollars at South Channel, between Crab Island and South Amboy.

Improving harbor at Stonington, Connecticut, thirty thousand dollars.

Improving harbor at Buffalo, New York, ninety thousand dollars.

Improving harbor at Charlotte, New York; repairs of piers, two thousand five hundred dollars.

Improving Echo Harbor, New Rochelle, New York, three thousand dollars.

Improving Flushing Bay, New York, ten thousand dollars.

Improving harbor at Great Sodus Bay, New York, five thousand dollars.

Improving harbor at Little Sodus Bay, New York, twenty thousand dollars.

Improving harbor at Olcott, New York, three thousand dollars.

Deepening and widening the channel in Gowanus Bay and the harbor of New York, forty thousand dollars.

Improving harbor at Port Jefferson, Long Island Sound, New York, four thousand dollars.

Improving harbor of New Rochelle, New York, twenty thousand dollars.

Improving harbor at Pulneyville, New York, two thousand dollars.

Improving harbor at Wilson, New York, ten thousand dollars.

Improving harbor at Waddington, New York, two thousand five hundred dollars.

Improving Ticonderoga River, New York, five thousand dollars.

Improving harbor at Erie, Pennsylvania, twenty thousand dollars.

Ice-harbor at Marcus Hook, Pennsylvania, thirty thousand dollars.

Pier in Delaware Bay, near Lewes, Delaware, ten thousand dollars.

Piers of ice-harbor at New Castle, Delaware: Completing improvement, twenty thousand dollars.

Improving harbor at Annapolis, Maryland, five thousand dollars.

Improving Breton Bay, Leonardtown, Maryland, three thousand dollars.

Improving the harbors and channels at Washington and Georgetown, District of Columbia, fifty thousand dollars.

Improving harbor at Norfolk, Virginia, and its approaches, seventy-five thousand dollars.

For enlargement and improvement, according to the plan and recommendation of the Engineer Department, of harbor facilities at Oswego, New York, including dredging entrance to harbor, fifty thousand dollars.

Improving Shrewsbury River, New Jersey: Completing improvement, eighty-six thousand dollars; of which sum thirty-six thousand dollars shall be expended on South Branch, and fifty thousand dollars on Main and North Branch.

Improving New River from lead mines in Wythe County, Virginia, to mouth of Greenbrier River, twenty-four thousand dollars; of which sum fifteen thousand dollars shall be expended in the continuation of the work from the mouth of Greenbrier up, and nine thousand dollars in the continuation of the work from the lead mines in Wythe County down.

Improving harbor at Charleston, South Carolina, one hundred and seventy-five thousand dollars.

Improving harbor at Brunswick, Georgia, five thousand dollars.

Improving Savannah Harbor and River, Georgia, sixty-five thousand dollars; of which sum one thousand dollars may be applied to payment of damages for land taken for widening the channel opposite Savannah.

Improving Apalachicola Bay, Florida, ten thousand dollars.

Improving Tampa Bay, Florida; completing the deepening of the bar and channel from the bar to the town of Tampa, ten thousand dollars.

Improving harbor at Mobile, Alabama, one hundred thousand dollars.

Improving Mississippi River at and near Vicksburg, and protection of harbor of Vicksburg, Mississippi, seventy-five thousand dollars.

Improving harbor at New Orleans, Louisiana, seventy-five thousand dollars.

Improving Galveston Harbor, Texas: Continuing operations at outer bar, two hundred and fifty thousand dollars.

Improving harbor at Ashtabula, Ohio: To secure a sixteen-foot channel, twenty thousand dollars.

Improving harbor at Black River, Ohio, seven thousand dollars.

Improving harbor at Cleveland, Ohio, two hundred thousand dollars.

Improving harbor at Fairport, Ohio, ten thousand dollars.

Improving harbor at Huron, Ohio, three thousand dollars.

Ice-harbor at mouth of Muskingum River, Ohio, thirty thousand dollars.

Improving harbor at Port Clinton, Ohio, five thousand dollars.

Improving harbor at Sandusky City, Ohio, ten thousand dollars.

Improving harbor at Toledo, Ohio, forty thousand dollars.

Improving harbor at Vermillion, Ohio, two thousand dollars.

Improving harbor at Michigan City, Indiana: Continuing operations at outside harbor, twenty thousand dollars; for continuing improvement on the inner harbor, twenty five thousand dollars.

Improving harbor at Calumet, Illinois, thirty thousand dollars.

Improving outside harbor at Chicago, Illinois: Dredging in outer harbor and constructing exterior breakwater, one hundred and fifty thousand dollars.

Improving Galena River and Harbor, Illinois, twelve thousand dollars.

Improving harbor at Rock Island, Illinois, six thousand dollars.

Improving Monongahela River, West Virginia and Pennsylvania, twenty-five thousand dollars: but this sum shall not be expended until the Monongahela Navigation Company shall have undertaken in good faith the building of lock and dam number seven, at Jacob's Creek, and until said company shall, in manner satisfactory to the Secretary of War, give assurance of their ability and purpose to complete the same.

Improving Shenandoah River, West Virginia, two thousand five hundred dollars; but this sum shall not be expended, nor shall the sum heretofore appropriated therefor be expended, until any corporate rights or franchies that may exist over said river shall have been relinquished to the United States to the satisfaction of the Secretary of War.

Improving harbor at Waukegan, Illinois, fifteen thousand dollars.

Ice-harbor at Saint Louis, Missouri, ten thousand dollars.

Improving harbor and the Mississippi River at Memphis, Tennessee, fifteen thousand dollars.

Improving harbor and river at Au Sable, Michigan, six thousand dollars.

Improving harbor at Charlevoix, Michigan, ten thousand dollars.

Improving harbor at Cheboygan, Michigan, six thousand dollars.

Improving harbor at Frankfort, Michigan, ten thousand dollars.

Improving harbor at Grand Haven, Michigan, fifty thousand dollars.

Improving harbor at Black Lake, Michigan: Continuing operations for completion of old project, six thousand dollars.

Harbor of refuge at Grand Marais, Michigan, twenty thousand dollars.

Harbor of refuge at Lake Huron, Michigan, fifty thousand dollars.

Improving harbor at Ludington, Michigan, ten thousand dollars.

Improving harbor at Manistee, Michigan, ten thousand dollars.

Improving Manistique Harbor, Michigan: Completing improvement, one thousand dollars.

Improving harbor at Monroe, Michigan, one thousand dollars.

Improving harbor at Muskegon, Michigan, twenty thousand dollars.

Improving harbor at Ontonagon, Michigan, twenty thousand dollars.

Improving harbor at Pentwater, Michigan, ten thousand dollars.

Harbor of refuge at Portage Lake, Michigan, ten thousand dollars.

Improving river and harbor at Saint Joseph, and waterchannel leading up to Benton Harbor, Michigan, ten thousand dollars.

Improving harbor at Saugatuck, Michigan, five thousand dollars.

Improving harbor at South Haven, Michigan, five thousand dollars.

Improving harbor at White River, Michigan, seven thousand five hundred dollars.

Improving Grand River from its mouth to the city of Grand Rapids, Michigan, ten thousand dollars.

Continuing improvement of Clinton River, Michigan, eight thousand dollars.

Removing bar at ice-harbor of refuge at Belle River, Michigan, seven thousand dollars.

Improving harbor at Ahnapee, Wisconsin, eight thousand dollars.

Improving harbor at Green Bay, Wisconsin, five thousand dollars.

Improving harbor at Kenosha, Wisconsin, five thousand dollars.

Improving Ohio River, three hundred and fifty thousand dollars; of which sum one hundred and fifty thousand dollars may, in the discretion of the engineers, be expended on Davis Island Dam, and two hundred thousand dollars on the river from its mouth to its head: *Provided*, That fifty thousand dollars of the last-named sum may, in the discretion of the engineers, be expended on Indiana Chute, and fifty thousand dollars of the last-named sum, or so much thereof as shall be necessary, shall be applied to the completion of the work on Grand Chain.

Improving harbor at Manitowoc, Wisconsin, four thousand dollars.

Improving harbor at Menomonee, Wisconsin, twelve thousand dollars.

Improving harbor at Milwaukee, Wisconsin: Extension and repairs of piers and dredging, eight thousand dollars.

Improving harbor at Port Washington, Wisconsin, seventeen thousand dollars.

Improving harbor at Racine, Wisconsin, six thousand dollars.

Improving harbor at Sheboygan, Wisconsin: Repairs, dredging and extension of piers, twenty-five thousand dollars.

Improving Superior Bay, Wisconsin: Dredging for improvement of natural entrance and for repairing existing works, ten thousand dollars.

Harbor of refuge at Sturgeon Bay Canal, Wisconsin, ten thousand dollars.

Improving harbor at Two Rivers, Wisconsin, fifteen thousand dollars.

Improving harbor at Oconto, Wisconsin, ten thousand dollars.

Improving harbor at Fort Madison, Iowa, two thousand five hundred dollars.

Improving harbor at Muscatine, Iowa, two thousand five hundred dollars.

Improving harbor at Grand Marais, Minnesota, twenty thousand dollars.

Improving harbor at Duluth, Minnesota, forty thousand dollars

Improving harbor at Wilmington, California, thirty-three thousand dollars.

Improving Humboldt Harbor and Bay, forty thousand dollars.

Improving Cathance River, Maine, six thousand dollars.

Improving the "Gut," opposite Bath, Maine, five thousand dollars.

Improving Kennebunk River, Maine: Completing improvement, two thousand dollars.

Improving Lubec Channel, Maine, forty-five thousand dollars.

Improving Exeter River, New Hampshire, fifteen thousand dollars; of which sum an amount not exceeding seven hundred and fifty dollars shall be available immediately, to be used in acquiring title to land used in the cut-off at "Ox Bow."

Improving Lamprey River, New Hampshire, below New Market, ten thousand dollars

Improving Winnipiseogee Lake, New Hampshire: Completing improvement, two thousand five hundred dollars: *Provided*, that no right to raise or lower the water-level of said lake is hereby granted to any person or corporation.

Improving Otter Creek, Vermont, two thousand dollars.

Improving Merrimac River, Massachusetts, nine thousand dollars.

Improving Taunton River, Massachusetts, twenty-five thousand dollars

Improving Providence River and Narragansett Bay, Rhode Island, sixty thousand dollars.

Improving Potonowut River, Rhode Island, five thousand dollars.

Improving Milwaukee Bay, for purposes of harbor of refuge, one hundred thousand dollars.

Improving Mississippi, Missouri and Arkansas Rivers: Removing snags, wrecks, and other obstructions, one hundred and eighty-five thousand dollars; of which sum eighty thousand dollars shall be expended on the Mississippi River, eight thousand dollars on the Missouri River, and twenty-five thousand dollars on the Arkansas River. And the work herein provided for shall be prosecuted at all seasons of the year, and especially between the first day of July and the first day of November of each year: *Provided*, That so much of said sum of eighty thousand dollars hereby appropriated to the Missouri River as may be necessary shall be expended in the construction of a snag and dredge boat to be used in said river, the balance of said eighty thousand dollars to be expended in operating said boat.

Improving Chippewa River, Wisconsin, ten thousand dollars; but this sum is appropriated subject to the same conditions and limitations imposed by section one of the Act approved March 3, eighteen hundred and seventy-nine, for the improvement of rivers and harbors, relating to said Chippewa River.

Improving Connecticut River below Hartford, Connecticut, thirty thousand dollars; of which sum ten thousand dollars shall be used to continue the work in progress on the bar at the mouth of the river, and three thousand dollars in dredging the channel below Rocky Hill.

Improving Housatonic River, Connecticut, two thousand dollars.

Improving Thames River, Connecticut, thirty thousand dollars.

Improving New London Harbor, Connecticut, four thousand three hundred dollars.

Removing obstructions in East River and Hell Gate, New York, two hundred thousand dollars.

Improving Buttermilk Channel, New York, sixty thousand dollars.

Improving Hudson River, New York, fifteen thousand dollars.

Improving Cheesequake's Creek, New Jersey, five thousand dollars.

Improving Cohansey Creek, New Jersey, seven thousand dollars.

Improving Elizabeth River, New Jersey, four thousand dollars.

Improving Passaic River, New Jersey, from Pennsylvania Railroad bridge to its mouth, fifty thousand dollars.

Improving Rahway River, New Jersey, ten thousand dollars.

Improving South River, New Jersey, six thousand dollars.

Improving Woodbridge Creek, New Jersey: Continuing improvement, five thousand dollars.

Improving Allegheny River, from mouth of French Creek to Pittsburgh, Pennsylvania, twenty-five thousand dollars.

Improving Schuylkill River, Pennsylvania, forty thousand dollars.

Improving Delaware River below Bridesburg, Pennsylvania, one hundred thousand dollars.

Improving Delaware River between Trenton, New Jersey, and Bridesburg, Pennsylvania, ten thousand dollars.

Improving Delaware River near Cherry Island Flats, one hundred thousand dollars.

Improving Delaware River at Schooner Ledge, Pennsylvania and Delaware, forty thousand dollars.

Improving Broadkiln River, Delaware, five thousand dollars.

For the improvement of the Mississippi River, in accordance with the plan therefor recommended in Executive Document number fifty-eight, second session Forty-sixth Congress, by the Mississippi River Commission, to be expended by the Secretary of War, with the advice and under the supervision of said commission, the sum of one million dollars. And it shall be the duty of said commission to take into consideration, and of the Secretary of War to extend operations, under their supervision, to tributaries of the Mississippi River to the extent, and no further, that may be necessary in the judgment of said commission to the perfection of the general and permanent improvement of said Mississippi River; but this clause shall not be construed to interfere with the prosecution by the War Department of the improvement of said Mississippi River and its tributaries under general appropriations made therefor: *Provided*, That no portion of the sum hereby appropriated shall be used in the repair or construction of levees for the purpose of preventing injury to lands by overflow, or for any other purpose whatever except as a means of deepening or improving the channel of said river. And it shall be the duty of said commission to make report, on or before the first day of January next, to the Secretary of War, for transmission by him to Congress, of a detailed statement of the work done, and of the expenditure made from the sum hereby appropriated, with their judgment upon the effect of such work, and the general practicability and estimate of the total cost of such improvements along said river from Cairo to the head of the passes.

Improving Broad Creek from its mouth to Laurel, Delaware, ten thousand dollars.

Improving mouth of Duck Creek, Delaware, three thousand dollars.

Improving Mispillion Creek, Delaware, three thousand five hundred dollars.

Improving Choptank River between Denton and Greensborough, Maryland, five thousand dollars.

Improving Elk River, Maryland, five thousand dollars.

Improving Secretary Creek, Maryland, three thousand dollars.

Improving Threadhaven Creek for three miles below Easton, Maryland, three thousand dollars.

Improving Wicomico River below Salisbury, Maryland: Completing improvement, two thousand dollars.

Improving Chester River from Spry's Landing to Crumpton, Maryland, six thousand five hundred dollars.

Improving water-passage between Deal's Island and Little Deal's Island, Maryland, five thousand dollars.

Improving Appomattox River, Virginia, twenty thousand dollars; to be expended on the improvement of the river and harbor at Petersburg, Virginia.

Improving Blackwater River, Virginia, one thousand five hundred dollars.

Improving Chickahominy River, Virginia, two thousand dollars.

Improving Dan River between Danville, Virginia, and Madison, North Carolina, eight thousand dollars.

Improving James River, Virginia, sixty thousand dollars.

Improving Mattaponi River, Virginia, three thousand three hundred dollars.

Improving mouth of Nomoni Creek, Virginia, two thousand dollars.

Improving North Landing River, Virginia and North Carolina, seven thousand five hundred dollars.

Improving Nottaway River, Virginia, two thousand dollars.

Improving Pagan Creek, Virginia, five thousand dollars.

Improving Pamunkey River, Virginia, two thousand five hundred dollars.

Dredging a channel through the flats in front of Mount Vernon, Virginia, one thousand five hundred dollars.

Improving Rappahannock River, Virginia, fifteen thousand dollars.

Improving Staunton River, Virginia, five thousand dollars.

Improving Totuski River, Virginia, two thousand five hundred dollars.

Improving Urbana Creek, Virginia, four thousand dollars.

Improving York River at West Point, Virginia, twenty-five thousand dollars.

Improving harbor at Baltimore, Maryland: Continuing operations for the shortening and deepening the channel to twenty-seven feet at mean low water, one hundred and fifty thousand dollars.

Improving Elk River, West Virginia, five thousand dollars.

Improving Great Kanawha River, and operation of works, West Virginia, two hundred thousand dollars.

Improving Guyandotte River, West Virginia, three thousand five hundred dollars.

Improving Little Kanawha River, West Virginia, forty thousand dollars: *Provided*, That no tolls shall be collected by the Little Kanawha Navigation Company for that part of the river improved by the general government.

Improving Cape Fear River, North Carolina, from the ocean to Wilmington, one hundred and forty thousand dollars.

Improving the Cape Fear River from Wilmington to Fayetteville, North Carolina, thirty thousand dollars: *Provided*, That the Secretary of War is directed to expend of the money hereby appropriated a sum not exceeding ten thousand dollars, to extinguish any claim of right held by any company or corporation to take tolls or make charges for the navigation of so much of said river as is above described: *And provided further*, That said claim of right shall be extinguished and released on or before the first day of December, eighteen hundred and eighty-one, and no part of this appropriation shall be expended in the improvement of said river until such claim of right is wholly extinguished and released: *Provided further*, That nothing herein contained shall be taken or held as a waiver on the part of the United States to the exclusive control of navigation of said river relieved from any charges or tolls imposed by any company or corporation.

Improving Currituck Sound, Coanjok Bay, North River and Bar, North Carolina, thirty thousand dollars.

Improving French Broad River, North Carolina, five thousand dollars.

Improving Neuse River from its mouth to head of navigation, North Carolina, thirty thousand dollars.

Improving Pamlico and Tar Rivers, North Carolina, eight thousand dollars.

Improving Scuppernong River, North Carolina, one thousand dollars.

Improving Trent River, North Carolina, five thousand dollars.

Improving Yadkin River, North Carolina, twelve thousand dollars.

Improving Contentnia Creek, North Carolina, ten thousand dollars.

Improving Beaufort Harbor, North Carolina, thirty thousand dollars.

Improving Lillington River, North Carolina, three thousand dollars.

Improving Ashley River, South Carolina, one thousand five hundred dollars.

Improving Great Pedee River, South Carolina, between Little Bluff and Cheraw, six thousand dollars.

Improving Waccemaw River, South Carolina, from its mouth up to Waccemaw Lake, North Carolina, ten thousand dollars.

Improving Town Creek, in North Carolina, one thousand dollars.

Improving Chattahoochie River, Georgia, twenty thousand dollars.

Improving Coosa River, Georgia and Alabama, sixty thousand dollars.

Improving Flint River, Georgia, fifteen thousand dollars.

Improving Ocmulgee River, Georgia, five thousand dollars.

Improving Oconee River, Georgia, two thousand five hundred dollars; of which sum one thousand five hundred dollars to be expended between Dublin and Oconee Bridge.

Improving Oostenaula and Coosawattee rivers, Georgia, one thousand dollars.

Improving Savannah River above Augusta, Georgia, eight thousand dollars.

Improving Apalachicola River, Florida, one thousand five hundred dollars.

Improving Choctawhatchee River, Florida and Alabama, up to Newton, ten thousand dollars.

Improving entrance to Cumberland Sound, between Amelia and Cumberland Islands, in Florida and Georgia, one hundred thousand dollars.

Improving Escambia River, Florida and Alabama, five thousand dollars.

Improving Saint John's River, Florida, one hundred thousand dollars.

Improving Pea's Creek, in Florida, seven thousand dollars.

Improving Withlacoochee River, in Florida, seven thousand five hundred dollars.

Improving Suwanee River, Florida, three thousand dollars.

Improving Volusia Bar, Florida, five thousand five hundred dollars.

Improving Alabama River, Alabama, twenty thousand dollars.

Improving Big Sunflower River, Mississippi, four thousand dollars.

Improving Noxubee River, Mississippi, eight thousand dollars.

Improving Pascagoula River, Mississippi, four thousand dollars.

Improving Pearl River below Jackson, Mississippi, twenty-five thousand dollars.

Improving Pearl River, Mississippi, from Jackson to Carthage, two thousand five hundred dollars.

Improving Tallahatchee River, Mississippi, three thousand dollars; of which sum two thousand dollars shall be expended above the mouth of Cold Water River to Batesville.

Improving Tombigbee River above Columbus, Mississippi, one thousand dollars.

Improving Yazoo River, Mississippi, six thousand dollars.

Improving Amite River, Louisiana, five thousand dollars.

Improving Bayou Courtableau from Port Barre to Atchafalaya, Louisiana, seven thousand five hundred dollars.

Improving Bayou Teche from Saint Martinville to Port Barre, Louisiana, twenty thousand dollars.

Improving Bayou Terrebonne, Louisiana: Completing improvement, eight thousand eight hundred dollars.

Removing raft in Red River and closing Tone's Bayou, Louisiana, ten thousand dollars.

Removing obstructions from Red River, Louisiana, ten thousand dollars. And the Secretary of War is hereby directed to cause a thorough survey to be made of the mouth of Red River, and a plan for its permanent improvement to be reported to Congress on or before the first Monday of December, eighteen hundred and eighty-one, with estimates of cost; and said survey and plan to be paid for out of the unexpended balance already appropriated for the mouth of Red River.

Improving Tangipahoa River, Louisiana, two thousand dollars.

Improving Vermillion River, Louisiana: Completing improvement, four thousand nine hundred dollars.

Improving Warrior and Tombigbee Rivers, Alabama and Mississippi, to be expended in the same proportions as the appropriation under the act of June eighteen hundred and eighty, twenty-five thousand dollars.

Improving Aransas Pass and Bay, up to Rockport and Corpus Christi, Texas, eighty thousand dollars.

Improving channel over bar at mouth of Brazos River, Texas, forty thousand dollars.

Improving Pass Cavallo Inlet into Matagorda Bay, Texas, sixty thousand dollars.

Improving ship-channel, Galveston Bay, Texas, fifty thousand dollars.

Improving Neches River, Texas, three thousand dollars.

Improving Sabine Pass and Blue Buck Bar, Texas, one hundred and fifty thousand dollars.

Improving Narrows of Sabine River above Orange, Texas, and to deepen channel at its mouth, seven thousand dollars.

Improving Trinity River, Texas, ten thousand dollars.

Improving Arkansas River between Fort Smith, Arkansas, and Wichita, Kansas, twenty four thousand dollars.

Improving Arkansas River at Pine Bluff, Arkansas, twenty-three thousand dollars.

Improving Black River, Arkansas and Missouri, six thousand dollars, to be applied from Poplar Bluff.

Improving Fourche Le Fevre River, Arkansas, three thousand dollars.

Improving Ouachita River, Arkansas and Louisiana, twelve thousand dollars.

Improving Saline River, Arkansas, five thousand dollars.

Improving White River between Jacksonport and Buffalo Shoals, Arkansas, eight thousand dollars.

Improving White and St. Francis rivers, Arkansas, eight thousand dollars.

Improving Big Hatchee River, Tennessee, three thousand five hundred dollars.

Improving Caney Fork River, Tennessee, four thousand dollars.

Improving Clinch River, Tennessee, three thousand dollars.

Improving Cumberland River above Nashville, Tennessee: From Nashville to Kentucky State line, fifteen thousand dollars; from Kentucky line to Smith's shoals, fifteen thousand dollars; at Smith's Shoals, completing improvement, ten thousand dollars.

Improving Cumberland River below Nashville, Tennessee, fifteen thousand dollars.

Improving Duck River, Tennessee, three thousand dollars.

Improving French Broad River above Knoxville, Tennessee, three thousand five hundred dollars.

Improving Hiwassee River, Tennessee, one thousand five hundred dollars.

Improving Obed's River, Tennessee, two thousand five hundred dollars.

Improving Tennessee River above Chattanooga, Tennessee, seven thousand dollars.

Improving Red River from its mouth to Port Royal, in Montgomery County, Tennessee, five thousand dollars.

Improving Tennessee River below Chattanooga, including Muscle Shoals and shoal at Reynoldsburgh, Tennessee and Alabama, two hundred and fifty thousand dollars.

Improving Kentucky River from its mouth to Three Forks, Kentucky, one hundred and twenty-five thousand dollars.

Improving Big Sandy River from Catlettsburgh, Kentucky, to head of navigation, fifty thousand dollars; of which sum forty-six thousand dollars shall be expended at Louisa, and four thousand dollars in the continuation of works on the upper river.

Improving Sandusky River, Ohio, seven thousand five hundred dollars.

Improving Wabash River, Indiana, fifty thousand dollars, one-half of which is to be used on the river above Vincennes.

Improving White River, Indiana, from Wabash River to Portersville, and to falls on West Fork, twenty thousand dollars.

Improving Illinois River, Illinois, two hundred and fifty thousand dollars.

Improving Mississippi River at and above Alexandria, Missouri, six thousand dollars.

Improving Mississippi River at or near Cape Girardeau and Minton's Point, Missouri, ten thousand dollars.

Improving Mississippi River from Des Moines Rapids to mouth of Illinois River, Illinois and Missouri, one hundred and seventy-five thousand dollars; and the sums of money heretofore appropriated for the improvement of the Mississippi between the Illinois and Missouri Rivers, and unexpended, are hereby reappropriated, and shall be applied to the improvement of the harbor and Mississipi River at Alton.

Improving Mississippi River between mouths of the Illinois and Ohio Rivers, Illinois and Missouri, six hundred thousand dollars.

Removing bar in Mississippi River opposite Dubuque, Iowa, five thousand dollars.

Completion of work of removing sand-bar in Mississippi River opposite Guttenberg, Iowa, five thousand dollars.

Improving Mississippi River at Hannibal, Missouri, twenty thousand dollars.

Improving Mississippi River at Natchez and Vidalia, Mississippi and Louisiana, fifty thousand dollars.

Improving Mississippi River above Falls of Saint Anthony, Minnesota, ten thousand dollars.

Improving Mississippi River from Saint Paul to Des Moines Rapids, Minnesota, Iowa, Missouri, Illinois and Wisconsin, two hundred thousand dollars.

Improving Quincy Bay, Illinois, ten thousand dollars.

Annual expense of gauging the waters of the Mississippi River and its tributaries: Continuing observations of the rise and fall of the river and its chief tributaries, as required by joint resolution of February twenty-first, eighteen hundred and seventy-one, five thousand dollars.

Improving Upper Mississippi River; operating snag boat and building light-draught steamer, twenty-five thousand dollars.

Improving Rock Island Rapids, Mississippi River, Iowa and Illinois: Completing improvement, eight thousand dollars.

Improving Des Moines Rapids, Iowa and Illinois, twenty-five thousand dollars. And hereafter, for the purpose of operating and keeping in repair the Des Moines Rapids Canal, and Saint Mary's Falls Canal, and Saint Clair Flats Canal, and the Louisville and Portland Canal, the Secretary of War is authorized to draw his requisition on the Secretary of the Treasury from time to time, which requisition shall be paid out of any money in the Treasury not otherwise appropriated.

Improving the Osage River, Kansas and Missouri, twenty thousand dollars.

Improving Cuivre River, Missouri, from mouth to Chain of Rocks, and removing snags and obstructions, five thousand dollars.

Improving Gasconade River, Missouri, ten thousand dollars.

Improving Missouri River at Atchison, Kansas, twenty thousand dollars.

Improving Missouri River from Kansas City to its mouth, thirty-five thousand dollars.

Improving Missouri River at Brownville, Nebraska, ten thousand dollars.

Improving Missouri River at Cedar City, Missouri, fifteen thousand dollars.

Improving Missouri River at Council Bluffs, Iowa, and at Omaha, Nebraska, thirty thousand dollars.

Improving Missouri River at Eastport, Iowa, and at Nebraska City, Nebraska, twenty thousand dollars.

Improving Missouri River at Plattsmouth, Nebraska, ten thousand dollars.

Improving Missouri River at or near Fort Leavenworth, Kansas, eight thousand dollars.

Improving Missouri River at and near Glasgow, Missouri, twenty thousand dollars.

Improving Missouri River at and near Kansas City, Missouri, twenty thousand dollars.

Improving Missouri River at Lexington, Missouri, ten thousand dollars.

Improving Missouri River at Saint Charles, Missouri, fifteen thousand dollars.

Improving Missouri River at and near Saint Joseph, Missouri, twenty thousand dollars.

Improving Missouri River at Sioux City, Iowa: For improvement of channel, seven thousand dollars.

Improving Missouri River at Vermillion, Dakota, fifteen thousand dollars.

Improving Missouri River above mouth of Yellowstone River, Dakota, forty thousand dollars.

Survey of Missouri River from its mouth to Fort Benton, Montana; continuing survey above Sioux City, thirty thousand dollars.

Improving Detroit River, Michigan, fifty thousand dollars.

Improving Saginaw River, Michigan, ten thousand dollars.

Improving Saint Mary's River and Saint Mary's Falls Canal, Michigan: Completing improvement, one hundred and fifty thousand dollars.

Repairs and contingencies of public works at Saint Anthony's Falls, Minnesota: To meet repairs necessary, present and prospective, fifteen thousand dollars, which shall be available immediately after the passage of this act.

Improving Saint Croix River below Taylor's Falls, Wisconsin, eight thousand dollars.

Improving Red River of the North, Minnesota and Dakota, eighteen thousand dollars.

Constructing a lock and dam at Goose Rapids, on the Red River of the North, Minnesota and Dakota, twenty thousand dollars.

Improving Yellowstone River, Montana and Dakota, twenty thousand dollars.

Continuing improvement at the entrance of Coos Bay Harbor, Oregon, thirty thousand dollars.

Canal around Cascades of Columbia River, Oregon, one hundred thousand dollars.

Improving Upper Columbia River, including Snake River, Oregon, fifteen thousand dollars.

Improving Lower Willamette and Columbia Rivers, from Portland, Oregon, to the sea, including bar at the mouth of Columbia River, Oregon, forty-five thousand dollars.

Improving Upper Willamette and Yamhill Rivers, Oregon, fifteen thousand dollars.

Improving Petalumas Creek, California, eight thousand dollars.

Improving Sacramento River, California, sixty thousand dollars.

Improving San Joaquin River, California, forty thousand dollars; ten thousand dollars of which amount may be used in the discretion of the engineer in the improvement of Mormon Slough.

Examinations and surveys at South Pass of Mississippi River: To ascertain the depth of water and width of channel secured and maintained from time to time by James B. Eads, at South Pass of the Mississippi River, and to enable the Secretary of War to report during the maintenance of the work, ten thousand dollars; and also to ascertain by soundings whether and to what extent, within a distance of five miles from the present mouth of the river at the South Pass, the gulf has filled up by deposits from the river since the construction of the Eads jetties.

Improving Fox and Wisconsin Rivers, Wisconsin, one hundred and twenty-five thousand dollars; of which sum fifty thousand dollars shall be expended in continuing the improvement of the Wisconsin River, and seventy-five thousand for continuing the improvement of the Fox River.

Improving Calcasieu Pass, Louisiana, twelve thousand dollars.

Improving Calcasieu River, Louisiana, from Phillips' Bluff to its mouth, three thousand dollars.

Improving Savannah River, Georgia, fifteen thousand dollars.

Improving Mississippi River at Andalusia, Illinois, six thousand dollars.

Improving Mississippi River at Louisiana, Missouri, ten thousand dollars.

Repairing breakwater on the Saint Croix River near Calais, four thousand dollars.

Improving Altamaha River, Georgia, five thousand dollars.

Improving Wappoo Cut, South Carolina, ten thousand dollars.

Improving Neabsco Creek, Virginia, five thousand dollars.

Improving Bayou Bartholomew, Louisiana and Arkansas, eight thousand dollars.

Improving Tensas River, Louisiana, three thousand dollars.

Improving Bayou Black, in Louisiana, ten thousand dollars.

Improving Bayou Boeuf, Louisiana, five thousand dollars.

Improving Current River, Missouri and Arkansas, from Donithan to its mouth, two thousand dollars.

Improving Rancocas River, New Jersey, ten thousand dollars.

Improving Christiana River and Wilmington Harbor, Delaware: Deepening the channel and improving the harbor of Christiana River from the Delaware River to and above the city of Wilmington, in accordance with the surveys and plans of the United States Engineer Department, fifty thousand dollars.

Improving Chester Creek, Pennsylvania, three thousand dollars.

Improving Mattawan Creek, New Jersey, fifteen thousand dollars.

Improving Raritan Bay, New Jersey, from Perth Amboy and South Amboy to the main ship-channel of Great Kiln, fifty thousand dollars.

Improving Newport Harbor, Rhode Island, twenty-five thousand dollars.

Improving Tradewater River, Kentucky, open navigation, three thousand dollars.

Improving Cumberland River, Kentucky, above mouth of Jelico, ten thousand dollars.

Improving Buffalo Bayou, Texas: To secure a channel of one hundred feet, twenty-five thousand dollars.

Improving Kewanee Harbor, Wisconsin, five thousand dollars.

Improving Niagara River, New York, five thousand dollars.

Improving Portland Harbor, Maine, twenty thousand dollars.

Improving Scituate Harbor, Massachusetts, ten thousand dollars.

Improving Moosabec Bar at Jonesport, Maine, ten thousand dollars.

Improving Wareham Harbor, Massachusetts, ten thousand dollars.

Improving Canarsie Bay, New York, five thousand dollars.

Improving Sheepshead Bay, New York, five thousand dollars.

Improving Salem River, New Jersey, three thousand dollars.

Improving Susquehanna River, Pennsylvania, above Richards' Island, fifteen thousand dollars.

Improving Susquehanna River, above and below Havre de Grace, Maryland, fifteen thousand dollars.

Improving Archer's Hope River, Virginia, five thousand dollars.

Improving Wateree River, South Carolina, eight thousand dollars.

Improving Santee River, South Carolina, by deepening and straightening its outlet to Winyah Bay through Mosquito Creek, twenty-two thousand dollars.

Improving Pensacola Harbor, Florida, twenty thousand dollars.

Improving Tchefuncte River, Louisiana, one thousand five hundred dollars.

Improving Tickfaw River, Louisiana, two thousand dollars.

Improving Bayou Teche, by connecting same with Grand Lake at Charenton, Louisiana, twenty-five thousand dollars.

Improving bar and harbor at Brazos, Santiago, Texas, seventy-five thousand dollars.

Improving Yallabusha River, Mississippi, three thousand five hundred dollars.

Improving Tchula Lake, Mississippi, three thousand dollars.

For the expenses of operating and maintaining the Louisville and Portland Canal for the fiscal year ending June thirtieth, eighteen hundred and eighty-one, forty-two thousand dollars, which sum shall be immediately available.

Improving entrance to Yaquina Bay, Oregon, ten thousand dollars.

Improving Cowlitz River, Washington Territory, one thousand dollars.

Of the amount now available for the improvement of Bayou La Fourche, Louisiana, the sum of five hundred dollars, or so much thereof as may be necessary, shall be expended in the removal of brick pier at Donaldsonville.

Improving Richmond Harbor, Kennebec River, Maine, ten thousand dollars; of which sum six thousand dollars shall be expended for wing-dams and dredging at the head of Swan's Island and at Hatch's Rock, and four thousand dollars in dredging and deepening the channel at the foot of Swan's Island according to the plan recommended by Lieutenant Russell.

For reservoirs upon the headwaters of the Mississippi River and its tributaries, one hundred and fifty thousand dollars; and this sum, together with the sum of seventy-five thousand dollars heretofore appropriated for the construction of a dam at Lake Winnibigoshish, shall be expended at such places on said headwaters of the Mississippi River and its tributaries as the Secretary of War shall determine: *And it is provided*, That compensation for any private property taken or appropriated for any of said improvements, and all damages to private property caused by the construction of any of said dams, by flowage or otherwise, shall be ascertained and determined under and in accordance with the laws of the State in which such private property is situated.

And the Secretary of the Interior is hereby authorized and directed to ascertain what, if any, injury is occasioned to the rights of any friendly Indians, occupying any Indian reservation, by the construction of any of said dams, or the cutting or the removing of trees or other materials from any such reservation for the construction or erection of any of said dams, and to determine the amount of damages payable to such Indians therefor; and all such damages to private property and to friendly Indians, when ascertained and determined in the manner herein directed and provided, shall be paid by the United States: *Provided, however*, That such damages shall not exceed ten per centum of the sums hereby and heretofore appropriated for the construction of said reservoirs.

Improving Sumpawamus Inlet, New York, five thousand dollars.

Improving the harbor at the entrance of Saint Jerome's Creek, Maryland, six thousand five hundred dollars.

For the improvement of Saint Jones River, in the State of Delaware, five thousand dollars.

Such parts of the money appropriated by this act for any particular improvement requiring locks and dams as may be necessary in the prosecution of such improvement may be expended in the purchase, voluntary or by condemnation, as the case may be, of necessary sites: *Provided*, That such expenditure shall be under the direction of the Secretary of War: *And provided further*, That if the owners of such lands shall refuse to sell them at reasonable prices, then the prices to be paid shall be determined and the title and jurisdiction

procured in the manner prescribed by the laws of the State in which such lands or sites are situated. It shall be the duty of the Secretary of War to apply the money herein appropriated for improvements, other than surveys and estimates, in carrying on the various works, as far as can be without actual detriment to the interest of the government, by contract. Where such works cannot be done by contract without injury to the public interest, they may be prosecuted by hired labor. Where said works are done by contract, such contract shall be made after sufficient public advertisement for proposals, in such manner and form as the Secretary of War shall prescribe; and such contracts shall be made with the lowest responsible bidders, accompanied by such securities as the Secretary of War shall require, conditioned for the faithful prosecution of the work according to such contract, and for the proper payment of all liabilities incurred in the prosecution thereof for labor and material.

SEC. 2. That the joint resolution approved July twentieth, eighteen hundred and sixty-eight, authorizing the construction of the bridge over the Mississippi River "to connect the island of Rock Island with the cities of Davenport and Rock Island," is hereby so amended as to require the Chicago, Rock Island & Pacific Railroad Company to charge for any cars carrying freight other than those passing over its own road and for its own cars when carrying freight for other roads, which it may carry across said bridge, a sum not exceeding three dollars for every loaded car, two-fifths of which sums shall be paid by said railroad company into the Treasury of the United States each month; and the monthly returns thus made shall be in such form, and with such authentication, as the Secretary of War shall direct.

SEC. 3. That the Secretary of War is hereby directed, at his discretion, to cause examinations or surveys, or both, and estimates of cost of improvements proper, to be made at the following points, namely:

Harbor of San Luis Obispo, California.

Tombigbee River, Mississippi, from Fulton to Warren's Mill.

The Chattahoochee River, in Georgia, between West Point and Bolton, on the Western & Atlantic Railroad, so as to complete the survey of that portion of said river.

Bear Creek, running into Yazoo River.

Harbor at Port Henry, on Lake Champlain.

Frankford Creek from its mouth in the Delaware River to Frankford Avenue.

Five Mile Point, above Bridesburg, Delaware River.

Mouth of the Mispillon, Delaware.

Mokelumne River, California, from its mouth at or near Woodbridge.

New York Bay between Sandy Hook and Coney Island Point.

Newton Creek, Camden County, from Delaware River to head of navigation.

Mantua Creek, Gloucester County, from Delaware River to head of navigation.

Maurice River from Delaware Bay to Millville, Cumberland County.

Salem and Cohansey Rivers, New Jersey.

Completing survey of Harlem River and through the Harlem Kilns to the East River.

Survey for harbor of refuge in Lake Pepin, at Stockholm, Wisconsin, and Lake City, Minnesota.

Beaver Bay, Minnesota, to ascertain the cost and practicability of making it a harbor of refuge.

Grand Portage Bay and Wans-wau-goising Bay, Minnesota, to determine which, if either, should be made a harbor of refuge.

Sackett's Harbor, New York.

Matagorda Bay at the mouth of Saint Mary's Bayou, near the town of Matagorda, Texas.

Harbors of Madison and Clinton, Connecticut.

Edgartown Harbor and South Beach, Massachusetts.

Staunton River, from Brook Neal, in Campbell County, to mouth of Pig River, Virginia.

Roanoake River, from Weldon, North Carolina, to Clarksville, Virginia.

Bear Creek, running from Northeast Mississippi into the Tennessee River.

To deepen the channel of the Harrisecket River from Weston's Point to Freeport Landing in Freeport, Maine.

The channel of Broad Creek on the west side of Kent Island, Maryland.

Harbor of Brunswick, on the Androscoggin River.

Buzzard's Bay and Barnstable Bay, Massachusetts, at the entrance of the proposed Cape Cod Canal.

Sabine Pass, Texas, through Sabine Lake and River to Orange add Sabine Lake, and Neches River to Beaumont, to ascertain the cost and practicability of a deep-water channel from Sabine Pass to Orange and Beaumont.

Old Town Creek, Mississippi.

Bar at mouth of Winyah Bay, near Georgetown, South Carolina.

Little Red River in Arkansas.

And the Secretary of War is hereby directed to cause to be made examinations and surveys, or both, and estimates of the cost of the further improvements necessary to be made in the Savannah River and Harbor to increase the depth of the water in said river and harbor from the bar up to the city to twenty-two feet, and to make an estimate of the cost of widening the channel of the Savannah River opposite the city to six hundred feet of uniform depth with the balance of the channel.

Young's, Lewis' and Clarke's, and Skipanon Rivers, entering into Young's Bay, in the county of Clatsop, near mouth of Columbia River, Oregon

Snake River, from Lewiston to the mouth of Salmon River, Idaho Territory.

Corsica Creek, Maryland.

Harbor at mouth of Cedar River, on Green Bay, Michigan.

Lynn Harbor, Massachusetts.

Merrimac River from Lawrence, Massachusetts, to Manchester, New Hampshire.

Channel between islands of North Hero and South Hero, Lake Champlain.

Little Tennessee River from its mouth on the Holston or Big Tennessee River to the mouth of Tellico River.

Dog Island Harbor, harbor of Key West, Crystal River, La Grange Bayou up to Freeport, Manatee River and Crooked River, Florida.

Indian River, Florida, at the north end, in view of opening of passage into the lagoon one-half mile east.

From a point between Ellis Island and the docks of New Jersey Central Railroad to a point between Robbins' Reef Light and Constable Hook, in waters of New York Bay, New Jersey.

Big Black River, Mississippi.

Outlet of harbor of Ship Island.

Harbor at Boloxi, Mississippi.

Harbor at Pascagoula, Mississippi.

Upper thoroughfare leading into Tangier Sound, Dell's Island, and Rock Creek, Maryland.

Fish Bend, near Fort Chartres, in the Mississippi River.

Murder Kiln, Delaware.

Delaware River

Potomac and Anacostia Rivers, in the vicinity of Washington, District of Columbia, with reference to the improvement of navigation, the establishment of the harbor-line, and the raising of the flats, so far as their improvement may be necessary to the improvement of navigation and the establishment of the harbor-line.

Mouth of Cedar River, Green Bay, Michigan.

Greenport Harbor, New York.

Survey for harbor of refuge at New Buffalo, Michigan.

The head-waters of the Cannon River, in Minnesota, with a view that the same may be added to the reservoir system of the Upper Mississippi.

The water connection between the Waccamaw and Cape Fear rivers, with the view of ascertaining if a continuous inland water connection cannot thereby be established.

Toledo, Ohio, for a straight channel to Lake Erie.

For harbor at Caseville, Saginaw Bay, Lake Huron.

The Calumet River from South Chicago to the village of Pullman, on Lake Calumet.

For a further survey of James River, for the purpose of ascertaining the practicability and cost of procuring a channel of twenty-five feet at full tide from Richmond to the mouth of the river.

Survey of Upper Machodoc Creek, a tributary of Potomac River.

Survey of Urbana Creek, a tributary of Rappahannock River, from the village of Urbana to the Oaks.

The harbor of Mamaroneck, New York.

Cumberland River at Smith's Shoals, in the State of Kentucky, to ascertain the practicability and the cost of a canal, with locks and dams, from the head to the foot of said shoals.

The harbor at the Delaware Breakwater, and the entrance thereto.

Indian River, in the State of Delaware, from its mouth to Millsborough.

Survey of the Clarion River from its mouth to Ridgway, Pennsylvania.

From Brazos de Santiago through Laguna Madre to Point Isabel, Texas, to ascertain the cost and practicability of a deep-water channel from the anchorage at Brazos de Santiago to the Railroad wharf at Point Isabel.

Survey for breakwater and harbor of refuge, at Milford, Connecticut.

Entrance to Gray's Harbor, Washington Territory.

Between Baker's Bay and Shoalwater Bay, Washington Territory, for canal for light-draught vessels.

Missouri River, at of near Arrow Rock.

For survey of Nishnabotana from Hamburg, Iowa, to its junction with the Missouri.

Skipton Creek, Maryland.

Bush River, Maryland, from Harford Furnace to Chesapeake Bay.

Licking River from its mouth to Falmouth, in Kentucky.

Oregon Inlet, in Dare County, in North Carolina.

Survey of Chehalis River, in Washington Territory.

Whiteoak, Meherrin, and New Rivers in North Carolina.

SEC. 4. That for the examinations and surveys herein provided for, and for incidental repairs of harbors for which there is no special appropriation, the sum of fifty thousand dollars is hereby appropriated out of any money in the Treasury not otherwise appropriated; and in every case where examinations or surveys are made, the report thereon shall embrace such information concerning the commercial importance, present and prospective, of the improvement contemplated thereby, and such general commercial statistics as the Secretary of War may be able to procure.

Approved, March 3, 1881.

GENERAL INTELLIGENCE.

☞ *We solicit and are always pleased to publish in these columns any items of interest that may be furnished us.*

GAS AND WATER.

Geo. H. Norman is the contractor for the Newburyport, Mass., water-works, which, after years of discussion, are now being constructed.

Three hundred million gallons of water are daily going to waste over the Cochituate and Sudbury River dams, and 150,000,000 gallons in the Mystic River, the sources by which Boston is supplied.

The Berkshire Water Company will probably proceed with their enterprise notwithstanding the fact that the Lee fire district will not accept their proposition to furnish them with water for fire purposes. They will get their water from Codding Brook, making a reservoir capable of holding 70,000,000 gallons of water and flooding 25 acres of land.

Messrs. Goodhue & Birnie, of Springfield, Mass., have been awarded the contract for the distribution, hydrants, gates, etc., of the Dedham, Mass., new water-works. The estimated quantities are: 12,641 feet 10-inch wrought-iron, cement-lined pipe, at $1.10 per foot; 2,540 feet of 8-inch at 90 cents; 17,381 feet of 6-inch at 75 cents; 4,537 feet of 4-inch at 55 cents; 100 feet 10-inch cast-iron pipe; 10 10-inch gates; 3 8-inch; 23 6-inch; 11 4-inch; 50 post hydrants, set complete, at $50; total contract price, $36,500; to be commenced May 1 and completed September 1 of this year.

ELECTRICITY.

Owing to an increase of nearly 65 per cent. in the gas bills of the White Star Steamship Line (which is attributed to the bad quality of gas), General Agent R. J. Cortis has adopted the United States Electric Light system for use on Pier No. 52, North River, this city. In addition to using this light on the pier, it is proposed to use it in the holds of the White Star steamers while loading and discharging, thus avoiding the risks and inconvenience of gas or kerosene. Mr. Cortis believes that the saving will be at least $100 a month, or 33 per cent.

Mr. John Caldwell, of the Westinghouse Air Brake Company, Mr. C. L. Magee and others are said to have entered into arrangements for the organization of a company for lighting the streets, public buildings and manufactories of Pittsburgh with electric light. The machines of the Brush Electric Company of Cleveland will be used with the addition of an improved motor invented by Mr. George Westinghouse, which overcomes the frictional forces more readily than the machines generally used. It will require three or four generators to furnish light for the city, and the street lights will be arranged at such distances as to make the light visible through the usual fog.

On the 22d inst. the Board of Aldermen of this city granted permission to the Edison Electric Light Company to lay tubes, wires, conductors and insulators, and to erect lamp-posts in the streets, avenues, parks and public places in this city for the purpose of supplying electricity for illumination. All excavations in streets, removals and replacements of pavements or sidewalks are to be made according to the direction of the Commissioner of Public Works, and under such conditions as to security against damage to sewers, water-pipes or gas pipes, as may be prescribed by the Mayor, Comptroller and Commissioners of Public Works, who are now by law authorized to make provision for lighting the streets of the city. Whenever a permit shall be granted to open the streets, pavements or sidewalks for the purpose of laying the tubes, wires, conductors, etc., a sum equal to 1 cent for each lineal foot of street occupied shall be paid to the city. Nothing in the resolution shall be deemed to authorize the laying of mains or pipes for conveying gas.

STREETS, DRAINAGE, ETC.

Messrs. Moran and Armstrong, prominent contractors of this city, have addressed the following testimonial to Messrs. J. B. White & Bros., of London, whose agent in this city is Mr. Howard Fleming, 23 Liberty st.:

"Last year we used 2,200 casks of your Portland cement for concreting the great tank of the Municipal Gas Light Co., the largest tank in the United States and probably in the world. The concrete was composed according to directions of the engineer, of one part of your Portland cement to three parts of sand and five parts of small stone; but we think that much larger additions could be made to your Portland cement, and the concrete would still be very strong and good. The satisfaction it has given to us has been very great. The cement was uniform in strength and fineness, and made superior concrete, that has not cracked or leaked after severe testing."

BRIDGES.

The contract for two iron bridges over Twenty Mile River, in Buckfield, Me., has been awarded to the Corrugated Metal Company of East Berlin, Conn. They also contracted last week for a bridge in Washington, Conn., and one in Norwalk, Conn.

G. Lindenthal, engineer of the Monongahela Bridge Co., opened the plans for the new structure which is to span the Monongahela River at Smithfield street to the general inspection of contractors. The plans have been entirely changed, and instead of a link suspension bridge a truss bridge of the Pauli system, of iron and steel, after the style of the bridge at Mayence on the Rhine will be built. This structure will be the first of its kind built in this country, and it will be designed with a view to allow the easy passage of steamboats with high smoke-stacks. The main points of difference between the abandoned plan and the new one are the length of the channel spans and the more gradual approaches at each end. The roadway will be supported by six piers, with the customary abutments on either bank. The first pier on the north side and the two piers next to the south bank will be of comparatively small size, and to a great measure bidden from view. The three channel piers, however, will be of great strength and size, extending about fifty-two feet above high-water mark, the same as the Pan Handle railroad bridge. The approaches to the channel piers from either bank will be built to the usual style of ordinary truss bridges, but the part between the three channel piers will be quite different in plan. Towers twenty-five feet in height will be erected on each pier and support a system of links and stays similar to that of the Point bridge. The intention is to have the support of this portion of the structure above the roadway in order to allow a free passage for high craft on the river. These towers and upper works will be highly ornamental. The channel piers will be provided with iron portals of fine architectural design. The channel spans will be each 360 feet in length and the approaches will consist of plate girder spans. The new arrangement is thought to be an important improvement on the old one, in two features especially. In the first place it makes a great saving in masonry in doing away with the massive stone archorages that would be necessary for the other plan, and then, besides, its simplicity admits of a much more rapid construction. The directors have not yet made up their minds as to whether the piers will be built wholly or in part of masonry; whether they are to be filled in with cement and dimension stone or finished in some other style. The abutment walls will be built of Homewood stone with rock-face finish and cut-stone coping. The size of the piers has not been definitely determined; it is said that the masonry will be completed by next August. It will be a source of surprise to some people to learn that the bridge will be for foot and wagon travel only, and has no arrangements for railway traffic. The Iron City Bridge Company held a contract under the old management for the construction of a suspension bridge. This contract amounted to $264,000, and covered not only the superstructure proper but the stone work and masonry. Of course, as the old plans were thrown aside, and inasmuch as the contractors had made considerable progress in the work, they presented a claim of damages. This bill was placed in the neighborhood of $80,000, and at present Dr. Hostetter and the contractors are figuring on a compromise, as that amount is considered rather high.

RAILROADS.

BOSTON, March 22.—The House of Representatives, by an overwhelming majority, this afternoon defeated the Elevated Railroad bill.

HARTFORD, CONN., March 24.—In the Senate to-day the bill to allow the Connecticut Valley Railroad to extend its road to the Massachusetts State line was defeated.

The New Sharon, Coal Valley & Eastern road in Iowa is now being surveyed from Lynnville to Newton, on the Chicago & Rock Island. It is rumored this road will become a part of the Wabash combination.

Engineer Robinson, of Ravena, Ohio, with assistants, has been surveying the Steubenville & Cleveland railroad to Carrollton, there to connect with the Carrollton Valley for Cleveland. Two routes will be surveyed.

Work has been commenced on the eastern approach to Gould's tunnel, east of Steubenville, O. Only about two dozen men are at work now, but when the full force intended for the work is on it will number about two hundred.

QUEBEC, March 22.—The Levis & Kennebec Railway was sold to-day at sheriff's sale at Levis. It was started at $50,000, and was finally adjudged to James R. Woodward, of Sherbrook, manager of the Quebec Central, for $192,000.

The track of the Carson & Colorado Railroad is now laid to a point 70 miles beyond Dayton, and 75 miles from the Mound House, the initial station of the road. Six car-loads of iron, twelve of ties and one of provisions and supplies leave Dayton daily for the end of the C. & C. track.

The survey of a line connecting the Dayton & Southeastern with the Cincinnati Northern at Lebanon, O., is being pushed rapidly, and the work of grading will begin as soon as the weather will permit. It is expected to have the road between Dayton and Lebanon completed by June 1.

There seems to be no doubt but that the Baltimore & Ohio Railroad will open a new line between Philadelphia and Baltimore at the earliest possible day. Arrangements are in progress with Colonel McComb by which the Delaware & Western Railroad may be purchased, but the rest of the line is not definitely agreed upon.

There is manifested in Castleton, Vt., a lively interest in a new railroad project. It is to build a road from the marble quarries along the line of slate quarries to intersect the Whitehall & Brattleboro Railroad. The distance will be 21 miles. Then a new connection will be made with the Central Hudson lines, via Manchester, and a saving of over 50 miles from the present route will be made.

At an early day, United States Commissioner Brazee, at Denver, Col., to legally conclude the transfer of that property, will sell the Boulder Valley Railroad under a decree of foreclosure entered by Jay Gould and other bondholders in December last. The foreclosure embraces all the property, franchises, etc., of the road, involving the sum of $591,083.32. The order of sale was made March 16.

The bill to enable the New Brunswick Railway to extend its line from Edmunston to Quebec has passed. The New Brunswick Railway, when completed, will reduce the distance from St. John to Quebec to about 388 miles, or just 200 miles less than it is now by the Intercolonial. It will bring St. John 297 miles nearer Quebec for the shipment of grain and other freight than Halifax now is by the Intercolonial.

KANSAS CITY, Mo., March 18.—The first through train on the Atchison, Topeka & Santa Fe Railroad for Deming, making connection with the Southern Pacific road for San Francisco, left the Union Depot last night at 9.50. There were seven cars in the train, all crowded; and among the passengers were fourteen tickets to San Francisco and points on the Southern Pacific. The train moved out of the depot amid the shouts of a crowd.

The Bangor & Piscataquis Railroad of Maine has re-elected its old board of directors and officers. The proposition to extend the road to Moosehead Lake is being considered. The corporators of the new Portland & Rochester Railroad have elected George P. Wescott President and William H. Conant Treasurer. The stockholders of the Penobscot & Lake Megantic road have voted to change its name to the International Railway Company of Maine.

The frost having now got out of the ground the contractors of the grading for the new extension of the Pennsylvania Railroad from Whiting's Junction to Point Pleasant via Toms River and the Atlantic beach are pushing the work with all the force of men they can get. The road-bed will be ready for the rails in a few weeks, and work on the bridge across Barnegat Bay is now beginning. By this route passengers will be enabled to reach the shore from Philadelphia in about twenty minutes less time than the express trains from the same city.

The future prospects of the Toronto, Grey & Bruce Railway Company are evidently very good. It is intended to widen the gauge, which will involve a large expenditure. At the last session of the Ontario Legislature power was granted to issue $1,000,000 of bonds for the proposed improvements. In addition to laying the road with steel rails, it is intended to reduce the curves, and construct iron bridges throughout the entire line. A grain elevator will be erected at Toronto and another at Owen Sound, which will afford greatly improved facilities for handling grain.

At a meeting of the stockholders of the Boston, Concord & Montreal Railroad held in Plymouth, N. H., on Monday, the directors were authorized to issue the bonds of the corporation in accordance with the act of the Legislature, passed in July, 1871, in such sums and at such interest as they deemed best for the corporation, and to secure the same by mortgage on the road. The directors were also authorized to appoint suitable trustees for said transactions. The road is about to make extensive improvements, including heavy blasting and the laying of steel rails.

Subscriptions to the second $3,000,000 of new stock of the Oregon Railway & Navigation Company were opened at the company's office Monday. The new stock is offered at par to the stockholders of record on March 21 in proportion to their respective holdings. The subscriptions are payable in installments, the last one falling due July 1. The purpose of this issue of new stock, as of the former issue of the same amount, is to furnish money for the completion of the company's railroad lines in Oregon. It is proposed to complete this year about 400 miles of road—the Columbia River line from Portland to the Dalles; the line from Umatilla to Baker City, and the line from Walla Walla to Colfax, with branches from Dayton to Pataha.

Work on the construction of the New York, Ontario & Western Railroad is reported as making satisfactory progress. A slight change has been made in the situation of the eastern end of the tunnel, which has been brought 1,400 feet further down stream, below Day's Point, to accommodate better the plans for the station. Since the station was planned, additional ground has been secured in that direction. The change also shortens the tunnel by 250 feet. The approach to this cut at the west end has reached the Hackensack plank road; gangs of laborers are now working on both of the portals; they are setting up the heavy machinery to be used in the excavation and have begun on each of the five shafts. It was expected to have the steam excavator at work to-day. At the Haverstraw and West Point tunnels work is also proceeding vigorously. Bids for the remainder of the work on the road between New York City and Middletown have been advertised for, and will be opened March 31.

NEW PROJECTS.

ALBANY, March 23.—The Northern Railroad Company of Long Island have filed articles of incorporation. The capital is $1,000,000.

DOVER, Del., March 24.—Another supplement to the Delaware Western Railroad charter was introduced in the Senate this morning, providing for a new road, beginning at Wilmington, to run down through the State in direct opposition to the Delaware Division of the Philadelphia, Wilmington & Baltimore road.

CLEVELAND, O., March 21.—About $1,500,000 of the $2,000,000 stock of the projected Pittsburgh, Youngstown & Chicago Railroad were subscribed on Saturday at Youngstown. The survey begins to-day. C. H. Andrews, George J. Margerum, T. W. Sanderson, H. M. Garlick and L. D. Cochrane were elected directors. They chose C. H. Andrews President, and H. M. Garlick Secretary.

A New Orleans dispatch says a party of railroad engineers arrived on the 18th at Bay St. Louis from the North, and will at once begin work on the New Orleans & Northeastern Railroad, which is to connect with the Cincinnati Southern. It is possible that this new route will be run so near Bay St. Louis as to give the New Orleans & Mobile line a competitor for the large summer travel to that point. The feasibility of running tracks along the lake shore from Milneburg to above the west end and thence into the city is being investigated.

A charter was granted at Harrisburg, Pa., on Tuesday last to the Reading & Chesapeake Canal and Railroad Company, with a capital of $2,500,000 in 50,000 shares of $50 each. It is organized to build a road from Reading to the Maryland line, there to connect with a road leading to Chesapeake Bay and with a branch from New Holland to Lancaster. Eleven thousand shares of stock have been subscribed for, 5,385 by Samuel L. Fowler, of Lancaster; 5,000 by D. R. Brower, of New York, and 500 by Samuel H. Price, of Lancaster. All the smaller stockholders are from Lancaster.

Four new railroads across Sussex County, N. J., are in contemplation. They are the Pennsylvania & New England, from Hamburg, Pa., via Water Gap and Poughkeepsie; the Warwick Valley, to connect the Pennsylvania's Belvidere Division at Belvidere with the Newburg branch of the Erie at Greycourt, and to be called, when completed, the Lehigh Valley & Hudson River Railroad; third, the New Jersey Midland's road from Ogdensburg, Sussex County, through Warren County to the Delaware, Lackawanna & Western's line at Water Gap, and thence to New York City; this is backed by the Midland's friends largely interested in Luzerne & Lackawanna counties coal lands; fourth, the Sussex Railroad, to unite Blairstown and Newton and connect with the Warwick Valley, making a through line from the Pennsylvania coal regions to New England.

The Sinaloa & Durango Railroad Co., limited, was organized last week in Boston, for the purpose of constructing a railroad and telegraph lines between Altater, on the Pacific Ocean, and Culeacan, with the privilege of extension to Durango, where it will connect with the International. The company are exempt from taxes for twenty years, from all duties on materials and plant; the right of way, 278 feet wide, and all land for stations, warehouses, etc., are given to the company free; the ore-beds, etc., are given, and, in addition to these privileges, a subsidy of $14,484 cash per mile is to be paid the company from the National Treasury of Mexico. The cost of building the line for forty miles is estimated at $500,000. Thomas N. Hart is President, Robert R. Symon is Vice-President. The office is 40 Water street, Boston. The surveys of the first forty miles have been made by Howard Schuyler, present Chief Engineer of the Mexican Central, and work will be commenced during the summer.

Messrs. E. W. Clark & Co., of Philadelphia, issued last week a prospectus for the organization of the Norfolk & Western Railroad Company, formerly the Atlantic, Mississippi & Ohio Railroad. The bonds have been sold to a syndicate of bankers led by Drexel, Morgan & Co., and this, with the proceeds of 135,000 shares of the preferred stock offered at $35, was taken up in three days in New York and Philadelphia in about equal proportions, thus securing the success of the enterprise at once. The success of this negotiation insures the prompt completion of the Shenandoah Valley Railroad to an intersection with the Norfolk & Western, and the gap of 93 miles will be built during the current year. As soon as the roads are united they will be run in harmony with each other. This will bring the Norfolk & Western Railroad within 250 miles of New York City, the northern terminus being Hagerstown, at which point it will connect with the Cumberland Valley, one of the branch roads of the Pennsylvania Railroad system, and over the latter system it will reach Philadelphia and New York.

A corps of engineers are now at work in Syracuse surveying various routes for the New York, Ontario & Western Railway. This company is formed to build a first-class railway on the west side of the Hudson River and the south side of the Mohawk, from Hoboken to Buffalo, where it will connect with railroads to the West. The organization means business, and has twenty million dollars in the treasury. At Little Falls 300 men are at work constructing the road through that section of the State. Engineers are at work surveying the line over the entire distance. The line is already located to the eastern boundary of Syracuse. It strikes the Central road east of the tunnel, and crosses it east of the tunnel and the Chenango Valley road. The corps of engineers have been at work all of this week surveying various routes.

Colonel Silas Seymour, ex-State Engineer of New York State, associate engineer of the road, in company with the attorney and claim agent of the road, went over the route surveyed by the engineer and carefully and closely inspected the various lines proposed. The engineers desire to locate the line through the north side of Syracuse and north of the Erie canal. Other routes will be surveyed before the line is decided upon.

Now that the Philadelphia capitalists, who are about to reclaim the immense tracts of land in the State of Florida known as the Everglades, have completed their contract with that State, it is no longer a secret that one of the main features of the gigantic scheme is the building of a ship-canal across the State of Florida. This project almost equals in importance that of reclaiming 12,000,000 acres of the richest land in the world south of the frost belt. A ship-canal across the State of Florida has been the dream of engineers for many years. It would not only shorten the distance between the American ports on the Atlantic coast and all European ports to New Orleans, Mobile and all shipping points on the Gulf of Mexico, but it would avoid the dangers to navigation which are experienced on the countless keys and coral reefs off the southern and southwestern coast of Florida. It is well known that a number of New York capitalists have been endeavoring for some years to get a charter from the State of Florida to build a ship-canal, but the Philadelphia Company have got ahead of them. At a very little expense a canal could be dug from the Kissimmee River to the St. John's River, which would give the company water communication nearly the entire length and breadth of the State of Florida.

CONTRACTING, MISCELLANEOUS, ETC.

An experiment is being made on the Providence Railroad of an engine with four cylinders, double the usual number, the advantages claimed being increased speed, with less danger of leaving the track, and a much steadier motion while running.

Accompanying the Pennsylvania State Geologist's report for last year, which has just appeared, is a "map of progress," showing in its civil divisions the location of all the new townships, some 243 in number. It has plainly marked all the lines of railroads, of which there are 1,700 miles, all the main roads in the State, and all the places where meteorological observations have been taken. The numerous iron and zinc mines are also indicated.

THE NEW JERSEY STATE GEOLOGICAL SURVEY.—The annual report for 1880 of the State Geologist of New Jersey, recently published, gives in detail the results of the last geological survey of the State. Considerable attention has been given to paleontology, and specimens of fossil fish and plants of the cretaceous, tertiary and post-tertiary ages have been collected. The production of iron ore is estimated at 840,000 tons, an increase of 350,000 tons above the product of 1879, and of 175,000 tons above that of 1873. The native fire-clays are reported to surpass those from the other States and from European countries. Silver has been found in the red sandstone region to the extent of three ounces and upwards to the ton. The percentage of copper is equally low, and no gold has been found in any of the assayed ore and specimens. The survey was made by Professor Geo. H. Cook, Professor John C. Smock, Assistant Geologist; Edwin H. Bogardus, Chemist; C. C. Vermeule, C. E.; N. L. Britton, B. S.; Professor J. S. Newberry and Professor R. P. Whitfield.